THE RELATIVE EFFECTIVENESS OF WRIST JOINT MANIPULATION VERSUS ULTRASOUND IN THE MANAGEMENT OF CARPAL TUNNEL SYNDROME

by

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A dissertation submitted in partial compliance with the requirements for the Master's Degree in Technology: Chiropractic in the faculty of Health at Technikon Natal.

I, Karuna Maharajh, do hereby declare that this dissertation is representative of my own work.

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DEDICATION

A humble dedication to Lord Shiva and Mother Durga- thank you for your constant guidance and love.

To my loving parents, Roshilla and Suresh- I am truly blessed to have you as my parents. Thank you for everything - your unrelenting, selfless support, your unconditional love and the values that you have inculcated in me. You have always inspired me to give off my best. I revere you both.

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ABSTRACT

Carpal Tunnel Syndrome is defined as a median nerve entrapment beneath the flexor retinaculum in the carpal canal such that it produces symptoms in the hand, wrist and upper extremity. A review of related literature suggests that statistics on the incidence of Carpal Tunnel Syndrome in South Africa are unavailable. In the U. S. A, Carpal Tunnel Syndrome occurs in 1% of the population and is the most frequently diagnosed peripheral neuropathy. Several studies investigating the use of conservative care in managing Carpal Tunnel Syndrome have been performed, but none have compared the effect of wrist joint manipulation and ultrasound in the management of Carpal Tunnel Syndrome. The purpose of this study was to investigate the effectiveness of wrist joint manipulation compared to ultrasound in the management of Carpal Tunnel Syndrome.

This randomized controlled clinical trial consisted of a study population of forty patients. The patients were randomly allocated to two groups of twenty each. One group received wrist joint manipulation while the other received ultrasound application to the palmar-radial aspect of the wrist. Both groups received four treatments over a two week period. Subjective measures included the Numerical Rating Scale-101 Questionnaire and the Carpal Tunnel Pain and Disability Form and objective measures consisted of the grip strength reading and goniometer readings for wrist flexion and extension. Both the subjective and objective measures were taken before the first and third visit and at the fifth follow- up consultation which took place during the following week. Inter-group analysis was done using the Mann-Whitney U test. Friedman's T test was used for intra-group analysis. α was set at the 0.05 level of significance. The results were illustrated by means of tables and bar- charts.

The results indicated that for intragroup analysis, a statistically significant difference existed for both groups, warranting the use of a multiple comparison procedure (Dunn's procedure) to determine at which stage the treatment made a significant difference. For all the measures except the wrist extension reading in the ultrasound group, most improvement occurred between the first and fifth consultations. For inter-group analysis, no significant difference for any of the measures, except the wrist extension readings, was present between the two groups indicating that both wrist joint manipulation and ultrasound were equally effective in treating Carpal Tunnel Syndrome. The improvement in wrist extension, in the wrist joint manipulation group was significantly better than that in the ultrasound group.

Although this study was limited by its single researcher design and could not clarify which treatment protocol was more effective, it supports the existing body of evidence in favour of both wrist joint manipulation and therapeutic ultrasound application in the management of Carpal Tunnel Syndrome.

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DEFINITION OF TERMS

Manipulation:

Manipulation is defined as a passive manoeuver in which specifically directed manual forces are applied to vertebral and extra-vertebral articulations of the body, with the object of restoring mobility to restricted areas.

- Long- lever manipulation: High- velocity force exerted on a point of the body some distance from the area where it is expected to have its beneficial effect.
- Short - lever manipulation: High - velocity thrust directed specifically at an isolated joint (Gatterman 1990: 140).

Joint Dysfunction:

This implies the loss of one or more movements within the normal range of motion (Schafer and Faye 1990: 27).

Contra-indication:

Any condition, especially any condition of disease, that renders one particular line of treatment improper or undesirable (Gatterman 1990: 407).

Biomechanics:

The study of the structure, function and mechanical aspects of human motion. It is concerned with external forces either of a static or dynamic nature dealing with human movements (Bergmann 1993: 755).

Differential diagnosis:

The determination of which of two or more diseases with similar symptoms is the one from which the patient is suffering (Illustrated Stedman's Medical Dictionary 1982).

Motion palpation:

Palpatory diagnosis of passive and active segmental joint ranges of motion (Gatterman 1990: 412).

CHAPTER ONE

1.1 INTRODUCTION

Carpal Tunnel Syndrome (CTS) is defined as a median nerve entrapment beneath the flexor retinaculum in the carpal canal such that it produces symptoms in the hand, wrist and upper extremity (Demopulos and Urbaniak 1996, Petruska 1997, Ebenbichler et al. 1998 and Dammers et al. 1999).

In the United States of America, CTS occurs in 1% of the population and is the most frequently diagnosed peripheral neuropathy (Demopulos and Urbaniak 1996).A review of related literature suggests that statistics on the incidence of CTS in South Africa are unavailable. It has been found that women are five times more likely to suffer from CTS than men. This has been attributed to the fact that women have congenitally smaller carpal tunnels (Greenly, 1998).

According to Greenly (1998), Bonebrake (1993) and Demopulos (1996),the aetiology of CTS arises from a compression of the median nerve in the carpal tunnel. This may occur when the volume of the carpal tunnel decreases or if the volume of its contents increases. Petruska (1997) has also stated that acute CTS may be caused by burns, hemorrhage, displaced fractures, unreduced dislocation of the carpal bones or Colles' fractures.

The patient usually complains of paraesthesia (with or without numbness and pain) in the fingers innervated by the median nerve together with weak thumb abduction (Ebenbichler et al. 1998). Patients may experience sleep disturbances due to numbness in the fingers. If severe, atrophy of the thenar muscles may occur (Demopulos and Urbaniak 1996).

Conservative treatment for CTS includes splinting, preventative and rehabilitative exercises,

ice, wrist manipulations, ultrasound and heat. Several studies by Bonebrake et al. (1990 and 1993), Valente and Gibson (1991 and 1994), Buchberger et al. (1996) and Petruska (1997), have tested the use of ultrasound application and wrist manipulation in conjunction with other conservative therapies in the management of CTS. Although these studies on conservative care of CTS have been performed, most have used a variety of interventions and therefore fail to show which ones are beneficial and which are not. This study aims to evaluate the relative effectiveness of wrist joint manipulation versus ultrasound in the management of CTS. Although one study performed by Ebenbichler et al. (1998) seemed to indicate that ultrasound was useful in the management of CTS, documentation regarding the role of wrist joint manipulation in CTS is lacking. Literature regarding the relative effectiveness of wrist joint manipulation and ultrasound is also lacking.

1.2 AIM

The purpose of this study is to evaluate the relative effectiveness of wrist joint manipulation compared to ultrasound in the management of Carpal Tunnel Syndrome.

1.3 OBJECTIVES

The first objective is to determine the relative effectiveness of wrist joint manipulation versus ultrasound in terms of subjective clinical findings.

The second objective is to determine the relative effectiveness of wrist joint manipulation versus ultrasound in terms of objective clinical findings.

CHAPTER TWO: LITERATURE REVIEW

2.1 INTRODUCTION

This chapter deals with relevant literature relating to CTS, as well as highlighting problems in its management.

According to Demopolus and Urbaniak (1996), CTS is the most frequently diagnosed peripheral neuropathy.

CTS is typically characterised by paraesthesia, burning or numbness in the median nerve distribution, which in many cases is worse at night (Magee 1997: 314-315; Bonebrake et al. 1993; Tetro et al. 1998). A weakness of grip strength and wasting of the thenar muscles may occur as the condition progresses (Browse 1997, Hope et al. 1998 and McLatchie 2000).

Conservative treatment includes wrist splinting, wrist joint manipulation and ultrasound application, while medical treatment includes corticosteroid therapy and surgery.

2.2 EPIDEMIOLOGY

Many authors have suggested that CTS is a relatively common disorder (Greenly 1998, Demopulos and Urbaniak 1996 and Ebenbichler 1998), however statistics indicating just how common it is, are rare. According to Bonebrake et al. (1993), the precise incidence of CTS is not known. In the United States of America, CTS occurs in 1% of the population (Demopulos and Urbaniak 1996) while a study conducted by Papanicolaou et al. (2001) (using questionnaires and telephonic interviews) revealed that CTS had a prevalence of 3,72%

in the US population. No reliable data documenting the incidence of CTS in South Africa could be found.

The age group most affected by CTS tends to be the forty to sixty year old age group, especially in people exposed to vibration in repetitive manual labour (Magee 1997: 315). According to Greenly (1998), CTS rarely affects young people, and affects women five times more frequently than men. This has been attributed to the fact that women have congenitally smaller carpal tunnels. Twenty per cent of pregnant women have a tendency to develop CTS due to the fluid retention that compresses the median nerve in the carpal tunnel (Magee 1997:314). Valente (1991) has stated that CTS occurs in people performing jobs that require manual dexterity eg. musicians, typists and grocers.

Opinion is divided over the percentage of patients who have CTS in both hands. According to Petruska (1997), CTS is bilateral in 50% of diagnosed patients. This opinion is not shared by Magee (1997: 315), who states that while CTS may occur bilaterally, it occurs more commonly in the dominant hand.

2.3 ANATOMY

The wrist joint consists of several articulations of the carpal bones with the radius and ulna, the metacarpals and each other. The carpal bones are arranged in two rows: the distal, relatively immobile row consists of the trapezium, trapezoid, capitate and hamate bones while the proximal, mobile row consists of the scaphoid, lunate, triquetrium and pisiform bones (Nordin and Frankel 1989: 261).

Several ligaments check the motion of the wrist. These can be divided into the intrinsic ligaments which originate and insert on the carpus, and the extrinsic ligaments which attach

from the radius to the carpus (Nordin and Frankel 1989: 262)

The carpal tunnel, which is about five centimetres long is defined by four palpable bony prominences i.e. the pisiform, the scaphoid tubercle, the hook of hamate and the trapezium tubercle. The flexor retinaculum, or transverse carpal ligament, which is a thick fibrous band, attaches to the pisiform and hamate hook on the medial side, while attaching to the scaphoid and trapezium tubercle on the lateral side (Demopulos and Urbaniak 1996 and Greenly 1998).

According to Nordin and Frankel (1989: 264-265), three flexor (Flexor carpi ulnaris, Flexor carpi radialis and Palmaris longus); three extensor (Extensor carpi radialis longus and brevis and Extensor carpi ulnaris); two pronator (Pronator teres and quadratus) and two supinator (Supinator and Brachioradialis) muscles control the movements of the wrist and forearm.

Nine flexor tendons and the median nerve go through the carpal tunnel (Valente 1991). The median nerve lies superficial to the flexor digitorum profundus and flexor pollicus longus tendons. It divides at the transverse carpal ligament into medial and lateral branches. The medial branch provides sensation to the ulna side of the index finger, the middle finger and the radial side of the ring finger. The lateral branch supplies sensation to the radial aspect of the index finger and both sides of the thumb while also giving rise to a motor branch which supplies the thenar eminence (Demopolus and Urbaniak 1996).

2.4 BIOMECHANICS

Wrist motion occurs in two planes: sagittal plane (flexion-extension) and frontal plane (radial/ulna deviation). Pronation and supination arises at the proximal and distal radial joints (Nordin and Frankel 1989: 265).

The normal range for flexion is 85 to 90 degrees with most of the motion (60%) occuring at the midcarpal joint and the rest of the motion (40%) occuring at the radiocarpal joint. The normal range for extension is 75-80 degrees with 67% of the motion at the radiocarpal joint and 33% at the midcarpal joint (Nordin and Frankel 1989: 265). With CTS, there is an increased intracarpal tunnel pressure, which increases more with wrist flexion and extension (Manente et al. 2001).

During radial deviation of the hand, the proximal row of carpal bones moves medially while the distal row moves laterally. This occurs in the normal range of 15-20 degrees, while the normal range of motion for ulna deviation is 35-37 degrees (Nordin and Frankel 1989: 266 and Magee 1997: 291).

Pronation and supination have a normal range of 85-90 degrees, with 75% of the movement occuring in the forearm articulation and 15% occuring in the wrist (Magee 1997: 290-291).

According to Nordin and Frankel (1989: 270), fine movement of the fingers and hand is dependent on wrist motion. The digital flexor tendons are found within the carpal arch. Wrist position affects the lengths of the digital flexor tendons and changes the position of the thumb and fingers, thereby affecting the ability to grip.

2.5 AETIOLOGY

There are several causes of CTS, all of which cause a compression of the median nerve. According to Demopolus and Urbaniak (1996), median nerve compression occurs when there is an increase in the volume of contents in the carpal canal or a decrease in the volume of the carpal tunnel. Bonebrake et al. (1990) has stated that a compression of the boundaries of the tunnel could also cause CTS and that certain pathological conditions such as osteoarthritis

and Paget's disease are causes of CTS.

McLatchie (2000: 416) has divided the aetiology of CTS into three groups:

1. Compression of the tunnel walls
   - Trauma (Colle's fracture, vibrating machinery)
   - Rheumatoid arthritis
   - Subluxation of the wrist
   - Acromegaly

2. Compression within the tunnel
   1. Fluid retention of pregnancy
   2. Myxoedema
   3. Benign tumours
   4. Chronic proliferative synovitis

3. Changes in the median nerve
   - Diabetes mellitus
   - Peripheral neuropathies

These aetiological factors in the development of CTS is included in the articles written by Valente (1991), Petruska (1997) and Bonebrake et al. (1993).

2.6 CLINICAL PICTURE AND DIAGNOSIS

CTS is a median nerve entrapment that is defined by an aching pain in the hand and arm (Hope et al. 1998: 462), burning, paraesthesia or numbness in the median nerve distribution

i.e. thumb, index, middle and radial half of the ring fingers (Magee 1997: 314-315, Bonebrake et al. 1993, Tetro et al. 1998).These symptoms are typically worse at night and relieved by hanging the hand over the edge of the bed and shaking it (Hope et al. 1998:462). Patients may also experience clumsiness due to sensory and motor changes, weakness of thumb abduction and pain migrating to the forearm, arm and elbow (Bonebrake et al. 1990 and Ebenbichler et al. 1998). Occasionally, light touch, two-point discrimination and sweating may be impaired (Hope et al. 1998). If severe, there may be weakness and wasting of the thenar muscles (Browse 1997, Hope et al. 1998 and McLatchie 2000).

The clinical diagnosis of CTS is usually made on history, physical signs and one or more positive provocative tests (Tetro et al. 1998). Several orthopaedic tests are available to confirm a diagnosis of CTS. These are (Greenly 1998, Magee 1997: 307-308):

- **Carpal compression test**: Performed by the examiner applying direct, even pressure over the median nerve in the carpal tunnel with the wrist supinated for up to 30 seconds.
- **Wrist flexion plus median nerve compression test**: Performed by holding the wrist in 60° flexion and applying a pressure on the median nerve for up to 30 seconds. According to Tetro et al. (1998), this test is more sensitive and specific than Phalen's test, which had a sensitivity of 61% and specificity of 83% and Tinel's test, which had a sensitivity of 74%. The values for the new test were: sensitivity of 82% and specificity of 99%.
- **Tinel's sign**: performed by tapping the median nerve at the wrist.
- **Phalen's test**: performed by examiner fully flexing the patient's wrists for 30 to 60 seconds.
- **Reverse Phalen's test**: Performed by holding the wrist fully extended for 30 to 60 seconds.

All these tests are positive if they reproduce the symptoms of CTS i.e. paraesthesia, numbness or burning in the median nerve distribution of the hand.

2.7 DIFFERENTIAL DIAGNOSIS

This list is compiled using the information from Petruska (1997) and Greenly (1998).

- **Raynaud's syndrome**

  This syndrome presents with a series of colour changes in the skin of the hands or feet following exposure to cold. The skin becomes white, cold and numb first, then blue, cold and numb and eventually red, hot and painful (Browse 1997: 178).

- **Thoracic Outlet Syndrome**

  This results from compression of the neurovascular bundle as it exits the chest to enter the upper limb. Neurological features include pain, paresthesias, weakness and numbness of the hand and arm. These symptoms are typical over the ulnar nerve distribution whereas CTS occurs over the median nerve distribution. Eden's, Adson's, Halstead's, Costoclavicular and Hyperabduction tests are some of the tests used to rule out this condition (McLatchie 2000: 238).

- **Peripheral neuritis/ neurological disease**

  The function of various nerves may be impaired when such conditions occur. Paresthesias, numbness and altered sensation may result. However, the deep tendon reflexes are usually decreased in such cases, and this does not occur in CTS. Examples of peripheral nerve disorders include myasthenia gravis, muscular dystrophy and peripheral polyneuropathies of alcoholism and diabetes (Bates et al. 1995: 549).

2.8 TREATMENT

2.8.1 SPLINTING

In a randomized controlled study conducted by Manente et al. (2001), the efficacy of a hand brace in the management of CTS was investigated. Eighty patients with unilateral CTS were included in the study- forty in the treatment group and forty in the control group. The treatment group were instructed to wear the brace every night for four weeks and this group had a significant improvement in subjective scores of patient's symptoms and functional status as compared to the control group. However objective readings showed no statistically significant difference between the groups. Valente (1991) wrote a case report on a patient who was treated for CTS with a treatment protocol that included splinting. The patient had both subjective and objective improvement. It was difficult to conclude whether the splinting was essential and even necessary in the treatment of CTS as a multitude of treatments was assessed.

2.8.2. CHIROPRACTIC INTERVENTION AND WRIST ULTRASOUND

Bonebrake et al. (1990) performed a controlled study on 38 individuals who were previously diagnosed with CTS and 13 asymptomatic individuals. The evaluation of CTS in respect to objective and subjective measures showed that individuals with CTS had lower values of strength, range of motion and slower task performance and higher values of pain and distress than the control group. Post-treatment values showed a 25% improvement in muscle strength, 22% in joint range of motion and 15% decrease in pain and distress values over pre-treatment

values. Treatment included hard tissue manipulation of the spine, various areas of the upper and lower extremities, including the wrist, shoulder girdle and ribcage. Other treatment included soft tissue manipulation, ultrasound (settings depended on individual patients), dietary advice and exercises. Bonebrake et al. (1993) then performed a six month follow-up study. Results showed that the patients maintained improvements in most objective measures (grip and pinch strength, range of motion and electromyograph signals of extensor carpi radialis and ulnaris), as well as pain and distress. Although these studies suggest that wrist manipulation is beneficial in the treatment of CTS, no strong conclusions can be drawn as the treatment protocol consisted of several different therapies, was not placebo-controlled, and therefore does not distinguish which modalities are beneficial and necessary, and which are not.

A randomized, double blind placebo-controlled study was performed by Ebenbichler et al. (1998) on forty-five patients with bilateral CTS. Active (therapeutic) ultrasound ($1W/cm^2$ for fifteen minutes, pulsed mode) was applied over one wrist and placebo ultrasound was applied over the other wrist for twenty treatments over seven weeks. Results showed an improvement in subjective symptoms (assessed by Visual Analogue Scale) , electroneurographic measures (taken with a Viking II Nicolet electromyograhy device) and sensory nerve conduction velocity in the active treatment group. These results were maintained at a six month follow-up examination. One problem with this study was that the subjective findings in each wrist could have been influenced by the effect of the treatment applied to the opposite wrist, confusing the subject and possibly resulting in an inaccurate perception.

Oztas et al. (1998) performed a patient- blinded, placebo-controlled trial. Eighteen women between the ages of 37 to 66 years were included in the study. Three groups of ten hands each were formed. The first group received $1.5W/cm^2$, the second received $0.8W/cm^2$ and the last received $0.0W/cm^2$. All the groups received continuous ultrasound, five minutes a session, five days a week, for two weeks. No significant difference in pain perception and nerve conduction velocity was noted between the groups, but a statistically significant

improvement in pain perception was noted in all groups. Eighteen patients, but thirty hands were used in the study, resulting in some patients falling into more than one group. The problem with this is that it adds another variable as some patients would have one hand treated and others both.

A number of case studies were performed by Valente (1991), Valente and Gibson (1994), Buchberger et al. (1996) and Petruska (1997). Valente (1991) did a case study on a 44 year old male with CTS. It revealed that chiropractic adjustments of the wrist, elbow and cervical spine, as well as splinting and ice, ultrasound and vitamin B6 seemed to benefit the patient more than medical treatment of Motrin and cortisone injections into the wrist, which he had been receiving for three years prior to seeking chiropractic care. He received chiropractic treatment three times a week for two months. The patient reported feeling better two weeks after starting chiropractic treatment. The second case study by Valente and Gibson (1994) demonstrated that chiropractic manipulations three times a week for four weeks to the subject's cervical spine, elbow and wrist produced a significant improvement in the symptoms and objective measures (electromyogram and grip strength readings). In the same article, Valente and Gibson also stated that although manipulation had been used to treat CTS, documentation was lacking. Another case study of a median nerve entrapment was done by Buchberger et al. (1996). Treatment included active muscle release technique, contract muscle relax technique, electrical muscle stimulation, diversified chiropractic manipulation to the carpal joints and active stretching and strengthening of wrist flexors and extensors. Treatments were applied twice a week for the first two weeks and observations followed for the following six months. The patient recovered sufficiently to return to normal occupational and social activities. Petruska (1997) successfully treated a machine operator with CTS using a combination of chiropractic manipulation, pneumatic decompression of the median nerve (CTD-Mark 1 pneumatic decompression device), microcurrent and nutritional supplements. Fixations in the cervical spine and upper extremity were manipulated and wrist flexion and extension exercises were then recommended (ten sets of ten repetitions once per day). The above four case studies seem to indicate that wrist adjustments and ultrasound may be

beneficial in the treatment of CTS. However, these studies fall short in that each study only analyses a single case, has multiple variables with no control groups and uses many interventions, and therefore statistically cannot be used to show the effect of either wrist joint manipulation or ultrasound on CTS.

2.8.3 CORTICOSTEROID THERAPY

A randomised double blind placebo controlled trial was performed by Dammers et al. (1999). One group was given lignocaine injections and the other was given lignocaine and methylprednisolone injections. Both groups received the injections proximal to the carpal tunnel. The patients who received the methylprednisolone experienced a significant improvement in their symptoms while those patients in the lignocaine group did not have a favourable response. These patients later received the methylprednisolone injection and they then experienced an improvement in their symptoms. According to Valente and Gibson (1994), steroidal therapy may cause complications such as aseptic necrosis and chemical neuritis.

2.8.4 SURGERY

Endoscopic carpal tunnel release has proven to be superior to open tunnel release because of the decreased pain in the post-operative period. A study conducted by Concannon et al. (2000) to investigate the recurrence rate after endoscopic carpal tunnel release, revealed there was a higher recurrence rate in the endoscopic release group as compared to the open release group. One hundred and three hands underwent open carpal tunnel release. Eighty eight had the endoscopic release. There were six recurrences in the endoscopic release group and none

in the open group.

According to Demopolus and Urbaniak (1996), the advantages of open surgery include direct visualization of anatomic structures, is safe and reliable and has a low risk of tendon or neurovascular injury while the disadvantages include scar tenderness, thenar pain, infection and reflex sympathetic dystrophy. They went on to discuss the pros and cons of endoscopic surgery. Pros included a low incidence of postoperative tenderness, earlier recovery of pinch strength and earlier return to work and daily activities, while cons included risk of tendon or neurovascular injury, direct examination of the carpal tunnel is not possible and the procedure has a greater cost.

CHAPTER THREE: MATERIALS AND METHODOLOGY

3.1 STUDY DESIGN AND PROTOCOL

The design was that of a prospective, randomised, controlled clinical trial. This study involved forty subjects from the greater Durban area using convenience sampling. Pamphlets were distributed door-to-door with the help of a distribution company, advertisements (Appendix J) were placed at local hairdressing salons, local libraries, shopping centers, and at the Technikon Natal and University of Durban Westville campuses. The advertisement stated that those patients who qualified for the study i.e. had Carpal Tunnel Syndrome and met the inclusion criteria, would receive free treatment. Upon telephonic reply, the potential subjects had the study protocol explained to them. Patients between the ages of sixteen and sixty, with no other symptomatic pathologies and who were not receiving any treatment for CTS were scheduled for an initial consultation.

3.1.1 STANDARD OF ACCEPTANCE

At the initial consultation, potential subjects underwent a case history (Appendix G), a relevant physical examination (Appendix H) as well as a wrist and hand regional examination (Appendix I).

These investigations were used to screen the patients for the inclusion and exclusion criteria. Following these investigations, a diagnosis of CTS was made.

3.1.2 INCLUSION CRITERIA

The inclusion criteria were based on information from Tetro et al. (1998), Hope et al. (1998: 462-463), Magee (1997: 314-315)and Bonebrake et al. (1993).

Only subjects who met the following inclusion criteria were included in the study:

1. Only patients aged 16 to 60 years were included in the study. CTS is more common in the 40-60 year age group, but may occur in young individuals who perform repetitive wrist action eg. musicians, regular computer mouse use.

2. Only patients diagnosed as having carpal tunnel syndrome were included in the study. All of the following may occur in one or both wrists or hands, but usually affect the dominant side. Patients with two or more of the following signs and two or more of the following symptoms were selected for the study.

SYMPTOMS:

- Aching pain in hand and arm
- Night pain
- Paraesthesia of thumb, index and middle fingers
- All of the above relieved by dangling hand over edge of bed and shaking it
- Burning in median nerve distribution
- Numbness in median nerve distribution

SIGNS:

- Decreased grip strength
- Positive Tinel's test at the wrist

- Positive Phalen's test
- Positive carpal compression test
- Positive wrist flexion plus median nerve compression

3.1.3 EXCLUSION CRITERIA

Exclusion criteria were based on information from Tetro et al. (1998), Berkow and Fletcher (1992: 140-142) and Haldeman (1992: 557-572). Subjects presenting with any of the following were excluded from the study.

1. Patients receiving any other treatment for this condition.
2. Patients for whom radiographs were deemed necessary to confirm a diagnosis.
3. Patients with evidence of contra-indication to wrist joint manipulation (Bergmann 1993: 132) or ultrasound application - this includes any known neoplastic, vascular or infectious diseases in the wrist or hand region (Kitchen and Bazin 1996:265).
4. Patient with signs and symptoms of proximal median nerve entrapment.
5. Patients with cervical root pain.
6. Patients with thoracic outlet syndrome.
7. Patients with any untreated condition causing a polyneuropathy (eg. Diabetes mellitus, uraemia, hypothyroidism, rheumatoid arthritis) or patients taking any drugs that may cause a polyneuropathy (eg. alcohol or isoniazid - 300mg/day).

Eligible patients were required to complete an informed consent form (Appendix B) after reading the research information sheet (Appendix A). The subjects were then randomly allocated to either Group A (wrist joint manipulation group) or Group B (ultrasound group) in the following manner: Each patient was required to draw a folded piece of paper from an envelope containing twenty pieces of paper marked "A" and twenty marked "B". Those who picked "A" received wrist joint manipulation, while those who picked "B" received ultrasound

to the wrist (Drew 1980: 202). All patients received a brief explanation of their diagnosed condition. Those patients who dropped out of the study were replaced by new patients in the same random process as before.

3.1.4 INTERVENTION

The patients received an explanation as to how the treatment modality they were receiving may be beneficial in treating their condition.

Motion palpation of the wrist was carried out in the manipulation group (Group A) according to Bergmann (1993: 626-632), in order to determine the presence of any fixated joints and the direction of manipulation of those fixated joints. This group was positioned for their wrist joint manipulation according to the diversified method (Bergmann 1993: 626-632). The direction of restricted motion, as well as the joint involved determined the wrist joint manipulation used. The force was directed into the restriction and in line with the articular plane (Schafer and Faye 1989:37). Group B received treatment with ultrasound (1 watt/cm^2, pulsed mode), which was administered over the palmar-radial aspect of the wrist, for five minutes with the patient in the seated position (Bonebrake et al. 1993 and Ebenbichler et al. (1998). Motion palpation of the wrist was carried out in this group as was done in the manipulation group.

After taking the findings by Valente (1991) and Buchberger et al. (1996) into account, it was decided that the patients would receive a maximum of four treatments over a two week period. Readings were taken before the first and third treatment, and at the fifth follow-up visit, which was scheduled during the week following the fourth treatment.

All patients were encouraged to continue with their normal daily activities.

3.1.5 ETHICAL CONSIDERATIONS

All patients took part in the study voluntarily and were not coerced into participating. They were informed that they could leave the study at any time with no repercussions on their future health care. Patients were also informed that any complaints could have been forwarded to the Technikon Natal Ethics Committee and that all patient information would be confidential.

Informed consent (Appendix B) was obtained from all the patients prior to commencement of treatment and relevant information was given to them in a Research Information Sheet (AppendixA) in a language they understood.

3.2 MEASUREMENT AND OBSERVATION

3.2.1 THE DATA

This study made use of both primary and secondary data as mentioned below:

3.2.1.1 THE PRIMARY DATA

- Case history (Appendix G)
- Physical examination (Appendix H)
- Wrist and hand regional examination (Appendix I)
- Carpal Tunnel Pain and Disability Form (Appendix C)
- NRS-101 (Appendix D)

- Goniometer readings (Apppendix E)
- Grip strength readings (Appendix F)

3.2.1.2 THE SECONDARY DATA

Current literature was obtained from journals, text books and the Internet which contained information on CTS and its treatment.

3.2.2 METHOD OF MEASUREMENT

3.2.2.1 SUBJECTIVE MEASUREMENT

I. Carpal Tunnel Pain and Disability Form (Appendix C)

The Carpal Tunnel Pain and Disability Form (Appendix C), modified from Levine et al. (1993), has two components i.e. the Symptom Severity Scale; which is a basic subjective rating of the patient's pain, paraesthesia, weakness, numbness and strength; and the Functional Status Scale, in which the patient rates the difficulty of daily activities (Magee 1997: 302-303). For the purposes of this study, the Symptom Severity Scale was used, as it encompassed most of the symptoms in the inclusion criteria in this study and was easy to understand. The maximum pain intensity score in the Carpal Tunnel Pain and Disability Form is 55. The score for each form was added up and recorded before the initial and third consultations, and at the fifth follow-up visit.

II. Numerical Rating Scale-101 (NRS-101) (Appendix D)

The NRS-101 consists of asking the patient to rate his/her perceived level of pain intensity on a numerical scale from 0 to 100 when at its worst and when at its least. For the purpose of this study, those patients who did not have pain, but rather had numbness/ tingling, were asked to rate numbness/tingling instead of pain on the NRS-101. The scores from NRS- 101 were represented as percentages and recorded separately for the initial, third and final visits in both groups.

According to Jensen et al. (1986) the Numerical Rating Scale-101 Questionnaire (Appendix D) is extremely simple to administer and score and could be measured either in written or verbal form. In this study Jensen et al. (1986) evaluated six different methods of determining pain intensity according to the following criteria:

- ease of administration of scoring
- relative rates of incorrect responding
- sensitivity as defined by statistical power
- the magnitude of the relationship between each scale and the linear combination of the pain indices, and
- sensitivity as defined by the number of available response categories.

They concluded that the NRS-101 appeared to be the most practical index.
Bolton and Wilkinson (1998) compared the responsiveness of the Visual Analogue Scale (VAS), the Verbal Rating Scale (VRS) and the Numerical Rating Scale (NRS-101). They found that the NRS-101 was the most responsive i.e. reliable, valid and sensitive to change of the measures when patients were asked to report their current levels of pain.

Questionnaires completed by the patients were screened to ensure that they had been completed correctly. The data was statistically analyzed with the level of significance (α) set at 5% or 0.05.

3.2.2.2 OBJECTIVE MEASUREMENT

I. Goniometer reading

The International Standard SFTR pocket goniometer from Baseline diagnostic and measuring instruments was used to measure range of motion (flexion and extension) of the wrist. This was done with the patient in the seated position.

II. Grip strength reading

Grip strength was measured using the grip dynamometer (suppliers Lasec - 32 Oldmo Road, Capetown). It was measured with the patient seated with elbow in 90° flexion (Balogun, 1991). All patients were asked to maintain a position of 25-35° of wrist extension, coupled with 7° ulnar deviation to record optimum grip strength (O'Driscall et al. 1991).

3.3 STATISTICAL ANALYSIS

A random population of forty patients was utilised in this study (n_1= 20, n_2 = 20), therefore non-parametric tests were used.

The Technikon Natal research statistician was consulted with regards to the manner in which data from the research study was to be analysed. Data was transferred into a spreadsheet in the SPSS© software package for statistical analysis (SPSS Inc. 1999).

The Mann-Whitney U test was used for inter-group analysis of the subjective and objective data. The Friedman's T test was used for intra-group analysis of the subjective

and objective data. These results were shown to be statistically significant, therefore further post-hoc testing was done. Reference will later on be made to the p value. The p value is a probability, with a value ranging from zero to one (Instat 2001). If the p value is small, it is highly unlikely that the difference between samples is caused by random sampling, it is therefore concluded that the samples have different means/medians.

3.3.1 INTER-GROUP COMPARISON (Manipulation group versus Ultrasound group)

The Mann-Whitney U test, a non-parametric test, was used to compare the manipulation and ultrasound groups with regard to the NRS-101, Carpal Tunnel Pain and Disability Form, grip strength reading and goniometer reading.

The above test was used to determine whether any significant difference existed between the wrist joint manipulation and ultrasound groups at the 1st, 3rd and 5th visits for each of the variables at the $\alpha = 0.05$ level of significance.

Hypothesis Testing:

The null hypothesis (H_0) stated that there was no difference in pain levels, with regards to the pain questionnaires, and no difference in the wrist range of motion and grip strength between the groups. The alternative hypothesis (H_1) stated that there was a difference in pain levels, with regards to the pain questionnaires and the goniometer and grip strength readings between the groups.

- H_0: There was no difference between the groups.
- H_1: There was a difference between the groups.
- $\alpha = 0.05$ = level of significance of the test.

Decision Rule:

For a two-tailed test:

- Reject Ho at α level of significance if $p < \alpha$.
- Do not reject H_0 at α level of significance if $p \geq \alpha$.

3.3.2 INTRA-GROUP COMPARISON (Manipulation group and Ultrasound group)

The Friedman's T test is a non-parametric test that compares three or more paired groups (Instat 2001). If the p value is small, one can conclude that at least one of the treatments differs from the rest, it is therefore necessary to look at post-hoc tests to determine which group differs from which other group (Instat 2001). In this study the post-hoc test used was a multiple comparison procedure called the Dunn Procedure (Daniel, 1978). The Friedman's T test was used within the wrist joint manipulation group and the ultrasound group to determine if there was any significant difference according to the NRS-101, Carpal Tunnel Pain and Disability Form, grip strength reading and goniometer readings between the first, third and fifth consultations.

Hypothesis Testing:

The null hypothesis (H_0) stated that there was no difference between consultations with regards to the variable of interest. The alternative hypothesis (H_1) stated that there was a difference between consultations with regards to the variable of interest.

$\alpha = 0.05$ = level of significance of the test.

Decision Rule:

For a one- tailed test:

- p = reported p - value/2 $< \alpha$ { if H1 is of form > and Z is positive; if H1 is of form < and Z is negative

- $p = 1 -$ (reported p value)/2 $< \alpha$ { if H1 is of form > and Z is negative; if H1 is of form < and Z is positive

- $\alpha = 0.05$

p was the observed significance level of the test.

(Thomas 2001).

The Dunn Procedure:

If the null hypothesis (H_0) was rejected for the Friedman's T Test, then this multiple comparison procedure had to be applied to determine which of the treatments were significantly different (Daniel, 1978).

3.4 SUMMARY

Forty patients suffering from Carpal Tunnel Syndrome were selected to participate in this study. Twenty patients were randomly allocated into the wrist joint manipulation group and the ultrasound group respectively. Each patient was assessed in terms of objective and subjective clinical findings and all the necessary data was obtained for statistical analysis.

CHAPTER FOUR: THE RESULTS

4.1 INTRODUCTION

This chapter deals with the demographic data and the results and their interpretations obtained after statistically analysing the data from the measurement criteria utilised, namely:

- the carpal tunnel pain and disability form
- the NRS-101 scores
- the goniometer readings
- the grip strength readings

4.2 CRITERIA GOVERNING THE ADMISSIBILITY OF DATA

Only data from patients who met the criteria of the study was included. Only measurements of the grip strength and goniometer taken by the researcher were used. All responses to the NRS-101 and Carpal Tunnel Pain and Disability Form that were included, were completed under the researcher's supervision.

Some patients had to be excluded when they did not meet the inclusion and exclusion criteria of the study. Examples include : patients over the age of sixty, patients with cervical nerve root entrapment and patients with suspected carpal fractures. Two patients who joined the study were non-compliant and were thus excluded from the study.

Key for Abbreviations used in the following tables:

Group A	:	Wrist Joint Manipulation Group
Group B	:	Ultrasound Group
Tx	:	Treatment
V.	:	Visit

4.3 DEMOGRAPHIC DATA

4.3.1 AGE DISTRIBUTION

Table 1: Age distribution within sample of 40 patients

AGE	GROUP A	GROUP	TOTAL (N=40)
16 - 29	3	2	5 (12.5%)
30 - 39	2	3	5 (12.5%)
40 - 49	7	8	15 (37.5%)
50 - 59	8	7	15 (37.5%)

4.3.2 GENDER DISTRIBUTION

Table 2: Gender Distribution within sample of 40 patients

GENDER	GROUP A	GROUP B	TOTAL (N=40)
Male	0	5	5 (12.5%)
Female	20	15	35 (87.5%)

4.3.3 RACE DISTRIBUTION

Table 3: Race Distribution within sample of 40 patients

ETHNIC GROUP	GROUP A	GROUP B	TOTAL (N=40)
Black	0	0	0 (0%)
Coloured	1	1	2 (5%)
Asian	4	8	12 (30%)
White	15	11	26 (65%)

4.3.4 CTS DISTRIBUTION

Table 4: CTS distribution according to side affected within sample of 40 patients

SIDE AFFECTED	GROUP A	GROUP B	TOTAL (N=40)
Unilateral Right	6	3	9 (22.5%)
Unilateral Left	5	8	13 (32.5%)
Bilateral	9	9	18 (45%)

4.4 RESULTS OF DATA ANALYSIS

4.4.1 INTER- GROUP COMPARISON (Group A versus Group B)

4.4.1.1 SUBJECTIVE MEASURES

4.4.1.1.1 NRS-101 QUESTIONNAIRE

Table 5: Comparison of Group A and Group B using the Mann- Whitney U test to analyse results obtained from the NRS-101 Questionnaire at visits 1, 3 and 5.

	GROUP A		GROUP B
	MEAN	p-value	MEAN
V. 1	23.6	0.092	17.4
V. 3	19.25	0.496	21.75
V. 5	21.5	0.587	19.5

The values that are shown for visit 1 are the values that were obtained before the first treatment indicating that both Group A and Group B started off similarly ($p \geq 0.05$).

The null hypothesis is accepted for the Numerical Rating Scale 101, indicating that at the $\alpha = 0.05$ level of significance there was **no difference** in pain/ numbness/ tingling perception between the groups.

4.4.1.1.2 CARPAL TUNNEL PAIN AND DISABILITY FORM

Table 6: Comparison of Group A and Group B using the Mann- Whitney U test to analyse results obtained from the Carpal Tunnel Pain and Disability Form at visits 1, 3 and 5.

	GROUP A		GROUP B
	MEAN	**p-value**	**MEAN**
V. 1	22.35	0.316	18.65
V. 3	17.88	0.155	23.13
V. 5	21.6	0.551	19.4

The values that are shown for visit 1 are the values that were obtained before the first treatment indicating that both Group A and Group B started off similarly ($p \geq 0.05$).

The null hypothesis is accepted for the Carpal Tunnel Pain and Disability Form, indicating that at the $\alpha = 0.05$ level of significance there was **no difference** in pain perception and disability between the groups.

4.4.1.2 OBJECTIVE MEASURES

4.4.1.2.1 GRIP STRENGTH READING

Table 7: Comparison of Group A and Group B using the Mann- Whitney U test to analyse results obtained from grip strength readings at visits 1, 3 and 5.

	GROUP A		GROUP B
	MEAN	p-value	MEAN
V. 1	17.55	0.109	23.45
V. 3	18.7	0.329	22.3
V. 5	18.83	0.363	22.17

The values that are shown for visit 1 are the values that were obtained before the first treatment indicating that both Group A and Group B started off similarly ($p \geq 0.05$).

The null hypothesis is accepted for the Grip Strength Readings, indicating that at the $\alpha = 0.05$ level of significance there was **no difference** in grip strength readings between the groups.

4.4.1.2.2 WRIST FLEXION READING

Table 8: Comparison of Group A and Group B using the Mann- Whitney U test to analyse results obtained from wrist flexion range of motion readings at visits 1, 3 and 5.

	GROUP A		GROUP B
	MEAN	**p-value**	**MEAN**
V. 1	17.38	0.079	23.63
V. 3	18.65	0.299	22.35
V. 5	19.35	0.517	21.65

The values that are shown for visit 1 are the values that were obtained before the first treatment indicating that both Group A and Group B started off similarly ($p \geq 0.05$).

The null hypothesis is accepted for the wrist flexion readings, indicating that at the $\alpha = 0.05$ level of significance there was **no difference** in wrist flexion readings between the groups.

4.4.1.2.3 WRIST EXTENSION READING

Table 9: Comparison of Group A and Group B using the Mann - Whitney U analyse results obtained from wrist extension range of motion readings at visits 1, 3 and 5.

	GROUP A		GROUP B
	MEAN	**p-value**	**MEAN**
V. 1	22.7	0.23	18.3
V. 3	24.2	0.043	16.8
V. 5	25.2	0.01	15.8

The values that are shown for visit 1 are the values that were obtained before the first treatment indicating that both Group A and Group B started off similarly ($p \geq 0.05$).

The null hypothesis is accepted for the wrist extension readings at visit 1, indicating that at the $\alpha = 0.05$ level of significance there was **no difference** between the groups.

The null hypothesis is rejected for the wrist extension readings at visits 3 and 5, indicating that at the $\alpha = 0.05$ level of significance there was a **statistically significant difference** between the groups. Group A has a higher mean score for wrist extension, indicating that at the 3rd and 5th consultations, the improvement in wrist extension in the wrist joint manipulation group was significantly better than that in Group B (ultrasound group).

4.4.2 INTRA- GROUP COMPARISON

4.4.2.1 SUBJECTIVE MEASURES

4.4.2.1.1 NRS- 101 QUESTIONNAIRE

Table 10: Comparison of groups A and B using the Friedman's T test to analyse results obtained within the groups from the NRS-101 at visits 1, 3 & 5.

NUMERICAL PAIN RATING SCALE (NRS-101)						
	GROUP A			**GROUP B**		
	V. 1	V. 3	V. 5	V. 1	V. 3	V. 5
MEAN	56.6	36	27.6	51	41.6	27.6
p-value	**0.000 (<0.001)**			**0.0005**		

For both groups A and B the null hypothesis is rejected for the Numerical Rating Scale 101, indicating that at the $\alpha = 0.05$ level of significance there was a **statistically significant** improvement in pain/ numbness/ tingling perception between the three consultations in each group.

4.4.2.1.2 CARPAL TUNNEL PAIN AND DISABILITY FORM

Table 11: Comparison of groups A and B using the Friedman's T test to analyse results obtained within the groups from the Carpal Tunnel Pain and Disability Form at visits 1, 3 & 5.

CARPAL TUNNEL PAIN AND DISABILITY FORM						
	GROUP A			GROUP B		
	V. 1	V. 3	V. 5	V. 1	V. 3	V. 5
MEAN	56	23.5	29	51	41.6	27.6
p-value	**0.000 (<0.001)**			**0.0005**		

For both groups A and B the null hypothesis is rejected for the Carpal Tunnel Pain and Disability Form, indicating that at the $\alpha = 0.05$ level of significance there was a **statistically significant improvement** in pain perception and disability between the three consultations in each group.

4.4.2.2 OBJECTIVE MEASURES

4.4.2.2.1 GRIP STRENGTH READING

Table 12: Comparison of groups A and B using the Friedman's T test to analyse results obtained within the groups from the Grip Strength Readings at visits 1, 3 & 5.

GRIP STRENGTH READING						
	GROUP A			GROUP B		
	V. 1	V. 3	V. 5	V. 1	V. 3	V. 5
MEAN	31.6	39.6	49	31	39.6	49.4
p-value	**0.005**			**0.0025**		

For both groups A and B the null hypothesis is rejected for the Grip Strength Reading, indicating that at the $\alpha = 0.05$ level of significance there was a **statistically significant improvement** in the grip strength between the three consultations in each group.

4.4.2.2.2 WRIST FLEXION READING

Table 13: Comparison of groups A and B using the Friedman's T test to analyse results obtained within the groups from the Wrist Flexion Goniometer Reading at visits 1, 3 & 5.

WRIST FLEXION READING						
	GROUP A			GROUP B		
	V. 1	V. 3	V. 5	V. 1	V. 3	V. 5
MEAN	23	42.6	54.4	28.4	42	49.4
p-value	**0.000 (<0.001)**			**0.0005**		

For both groups A and B the null hypothesis is rejected for the wrist flexion goniometer reading, indicating that at the $\alpha = 0.05$ level of significance there was a **statistically significant improvement** in wrist flexion between the three consultations in each group.

4.4.2.2.3 WRIST EXTENSION READING

Table 14: Comparison of groups A and B using the Friedman's T test to analyse results obtained within the groups from the Wrist Extension Goniometer Reading at visits 1, 3 & 5.

WRIST EXTENSION READING						
	GROUP A			GROUP B		
	V. 1	V. 3	V. 5	V. 1	V. 3	V. 5
MEAN	26.6	43.4	50	33	45.6	41.6
p-value	**0.000 (<0.001)**			**0.0205**		

For both groups A and B the null hypothesis is rejected for the wrist extension goniometer reading, indicating that at the $\alpha = 0.05$ level of significance there was a **statistically significant improvement** in wrist extension between the three consultations in each group.

4.4.2.3 THE DUNN'S PROCEDURE (MULTIPLE COMPARISON TEST)

If the null hypothesis (H_0) is rejected for the Friedman's T test, then this multiple comparison procedure will have to be applied to determine between which treatments a significant improvement occurred (Daniel 1978).

The null hypothesis was rejected for the objective and subjective findings of Group A and B. It was then necessary to apply the Dunn's procedure (described below) to the pain and disability questionnaires, grip strength and goniometer readings to determine which of the treatments were significantly different.

Let V_j and V_j^1 be the j^{th} and $j^{1\,th}$ treatment rank totals .

Let α be the experiment-wise error rate. Usually $\alpha = 0.10$

If $|V_j - V_j^1| \geq z\sqrt{\frac{bk(k+1)}{6}}$, then V_j and V_j^1 are declared significant.

In the above formula:

b = the number of blocks

k = the number of readings

z = value in inverse normal distribution corresponding to (1- [α/k (k-1)])

In this case, k=3, b=20, α=0.10 and z=2.12.

i.e. If the difference of rank totals $\geq$ 13.408, then V_j and V_j^1 are declared significant.

For the purposes of this study, V_1 is the 1st visit, V_3 is the 3rd visit and V_5 is the 5th visit.

4.4.2.3.1 SUBJECTIVE MEASURES

4.4.2.3.1.1 NRS-101 QUESTIONNAIRE IN GROUP A

Table 15: Dunn's procedure for the NRS- 101 - (GROUP A)

	Rank Total	Difference	Rank Total	
V. 1	56.6	20.6	36	V. 3
V. 1	56.6	29	27.6	V. 5
V. 3	36	8.4	27.6	V. 5

$V_1 - V_3 = 20.6 \geq 13.408$, therefore between consultations **1 and 3**, the result is declared **statistically significant**.

$V_1 - V_5 = 29.0 \geq 13.408$, therefore between consultations **1 and 5**, the result is declared **statistically significant**.

$V_3 - V_5 = 8.4 < 13.408$, therefore between consultations **3 and 5**, the result is declared **statistically insignificant**.

This implies that a significant improvement exists between visits 1 and 3, and 1 and 5 but no improvement can be demonstrated between visits 3 and 5 with regard to the subjective data on pain perception for Group A.

4.4.2.3.1.2 NRS- 101 QUESTIONNAIRE IN GROUP B

Table 16: Dunn's procedure for the NRS- 101 - (GROUP B)

	Rank Totals	Difference	Rank Totals	
V. 1	51	9.4	41.6	V. 3
V. 1	51	23.4	27.6	V. 5
V. 3	41.6	14	27.6	V. 5

$V_1 - V_3 = 9.4 < 13.408$, therefore between consultations **1 and 3**, the result is declared **statistically insignificant**.

$V_1 - V_5 = 23.4 > 13.408$, therefore between consultations **1 and 5**, the result is declared **statistically significant**.

$V_3 - V_5 = 14.0 > 13.408$, therefore between consultations **3 and 5**, the result is declared **statistically significant**.

This implies that a significant improvement exists between visits 1 and 5, and 3 and 5 but no improvement can be demonstrated between visits 1 and 3 with regard to the subjective data on pain perception for Group B.

4.4.2.3.1.3 CARPAL TUNNEL PAIN AND DISABILITY FORM IN GROUP A

Table 17: Dunn's procedure for the Carpal tunnel Pain and Disability Form - (GROUP A)

	Rank Totals	Difference	Rank Totals	
V. 1	56	21	35	V. 3
V. 1	56	27	29	V. 5
V. 3	35	6	29	V. 5

$V_1 - V_3 = 21.0 > 13.408$, therefore between consultations **1 and 3**, the result is declared **statistically significant**.

$V_1 - V_5 = 27.0 > 13.408$, therefore between consultations **1 and 5**, the result is declared **statistically significant**.

$V_3 - V_5 = 6.0 < 13.408$, therefore between consultations **3 and 5**, the result is declared **statistically insignificant**.

This implies that a significant improvement exists between visits 1 and 3, and 1 and 5 but no improvement can be demonstrated between visits 3 and 5 with regard to the subjective data on pain and disability perception for Group A.

4.4.2.3.1.4 CARPAL TUNNEL PAIN AND DISABILITY FORM IN GROUP B

Table 18: Dunn's procedure for the Carpal tunnel Pain and Disability Form - (GROUP B)

	Rank Totals	Difference	Rank Totals	
V. 1	51	9.4	41.6	V. 3
V. 1	51	23.4	27.6	V. 5
V. 3	41.6	14	27.6	V. 5

$V_1 - V_3 = 9.4 < 13.408$, therefore between consultations **1 and 3**, the result is declared **statistically insignificant**.

$V_1 - V_5 = 23.4 > 13.408$, therefore between consultations **1 and 5**, the result is declared **statistically significant**.

$V_3 - V_5 = 14.0 > 13.408$, therefore between consultations **3 and 5**, the result is declared **statistically significant**.

This implies that a significant improvement exists between visits 1 and 5, and 3 and 5 but no improvement can be demonstrated between visits 1 and 3 with regard to the subjective data on pain and disability perception for Group B.

4.4.2.3.2 OBJECTIVE MEASURES

4.4.2.3.2.1 GRIP STRENGTH READING IN GROUP A

Table 19: Dunn's procedure for the Grip Strength Reading - (GROUP A)

	Rank Totals	Difference	Rank Totals	
V. 1	31.6	8	39.6	V. 3
V. 1	31.6	17.4	49	V. 5
V. 3	39.6	9.4	49	V. 5

$V_1 - V_3 = 8.0 < 13.408$, therefore between consultations **1 and 3**, the result is declared **statistically insignificant**.

$V_1 - V_5 = 17.4 > 13.408$, therefore between consultations **1 and 5**, the result is declared **statistically significant**.

$V_3 - V_5 = 9.4 < 13.408$, therefore between consultations **3 and 5**, the result is declared **statistically insignificant**.

This implies that a significant improvement exists between visits 1 and 5, but no improvement can be demonstrated between visits 1 and 3 and visits 3 and 5 with regard to the grip strength reading for Group A.

4.4.2.3.2.2 GRIP STRENGTH READING IN GROUP B

Table 20: Dunn's procedure for the Grip Strength Reading - (GROUP B)

	Rank Totals	Difference	Rank Totals	
V. 1	31	8.6	39.6	V. 3
V. 1	31	18.4	49.4	V. 5
V. 3	39.6	9.8	49.4	V. 5

$V_1 - V_3 = 8.6 < 13.408$, therefore between consultations **1 and 3**, the result is declared **statistically insignificant**.

$V_1 - V_5 = 18.4 > 13.408$, therefore between consultations **1 and 5**, the result is declared **statistically significant**.

$V_3 - V_5 = 9.8 < 13.408$, therefore between consultations **3 and 5**, the result is declared **statistically insignificant**.

This implies that a significant improvement exists between visits 1 and 5, but no improvement can be demonstrated between visits 1 and 3 and visits 3 and 5 with regard to the grip strength reading for Group B.

4.4.2.3.2.3 WRIST FLEXION READING IN GROUP A

Table 21: Dunn's procedure for the Wrist Flexion Reading - (GROUP A)

	Rank Totals	Difference	Rank Totals	
V. 1	23	19.6	42.6	V. 3
V. 1	23	31.4	54.4	V. 5
V. 3	42.6	11.8	54.4	V. 5

$V_1 - V_3 = 19.6 > 13.408$, therefore between consultations **1 and 3**, the result is declared **statistically significant**.

$V_1 - V_5 = 31.4 > 13.408$, therefore between consultations **1 and 5**, the result is declared **statistically significant**.

$V_3 - V_5 = 11.8 < 13.408$, therefore between consultations **3 and 5**, the result is declared **statistically insignificant**.

This implies that a significant improvement exists between visits 1 and 3, and 1 and 5 but no improvement can be demonstrated between visits 3 and 5 with regard to the wrist flexion goniometer reading for Group A.

4.4.2.3.2.4 WRIST FLEXION READING IN GROUP B

Table 22: Dunn's procedure for the Wrist Flexion Reading - (GROUP B)

	Rank Totals	Difference	Rank Totals	
V. 1	28.4	13.6	42	V. 3
V. 1	28.4	21	49.4	V. 5
V. 3	42	7.4	49.4	V. 5

$V_1 - V_3 = 13.6 > 13.408$, therefore between consultations **1 and 3**, the result is declared **statistically significant**.

$V_1 - V_5 = 21.0 > 13.408$, therefore between consultations **1 and 5**, the result is declared **statistically significant**.

$V_3 - V_5 = 7.4 < 13.408$, therefore between consultations **3 and 5**, the result is declared **statistically insignificant**.

This implies that a significant improvement exists between visits 1 and 3, and 1 and 5 but no improvement can be demonstrated between visits 3 and 5 with regard to the wrist flexion goniometer reading for Group B.

4.4.2.3.2.5 WRIST EXTENSION READING IN GROUP A

Table 23: Dunn's procedure for the Wrist Extension Reading - (GROUP A)

	Rank Totals	Difference	Rank totals	
V. 1	26.6	16.8	43.4	V. 3
V. 1	26.6	23.4	50	V. 5
V. 3	43.4	6.6	50	V. 5

$V_1 - V_3 = 16.8 > 13.408$, therefore between consultations **1 and 3**, the result is declared **statistically significant**.

$V_1 - V_5 = 23.4 > 13.408$, therefore between consultations **1 and 5**, the result is declared **statistically significant**.

$V_3 - V_5 = 6.6 < 13.408$, therefore between consultations **3 and 5**, the result is declared **statistically insignificant**.

This implies that a significant improvement exists between visits 1 and 3, and 1 and 5 but no improvement can be demonstrated between visits 3 and 5 with regard to the wrist extension goniometer reading for Group A.

4.4.2.3.2.6 WRIST EXTENSION READING IN GROUP B

Table 24: Dunn's procedure for the Wrist Extension Reading- (GROUP B)

	Rank Totals	Difference	Rank Totals	
V. 1	33	8.6	41.6	V. 3
V. 1	33	12.6	45.6	V. 5
V. 3	41.6	4	45.6	V. 5

$V_1 - V_3 = 8.6 < 13.408$, therefore between consultations **1 and 3**, the result is declared **statistically insignificant**.

$V_1 - V_5 = 12.6 < 13.408$, therefore between consultations **1 and 5**, the result is declared **statistically insignificant**.

$V_3 - V_5 = 4.0 < 13.408$, therefore between consultations **3 and 5**, the result is declared **statistically insignificant**.

This implies that no improvement exists between visits 1 and 3, 1 and 5 and visits 3 and 5 with regard to the wrist extension goniometer reading for Group B.

4.5 COMPARISON OF TRENDS

Figures 1 - 5 are visual representations of the mean value changes of Group A and B found within the 1st, 3rd and 5th consultations. These graphs serve to indicate trends within the 2 groups.

4.5.1 MEAN NRS-101 VALUES

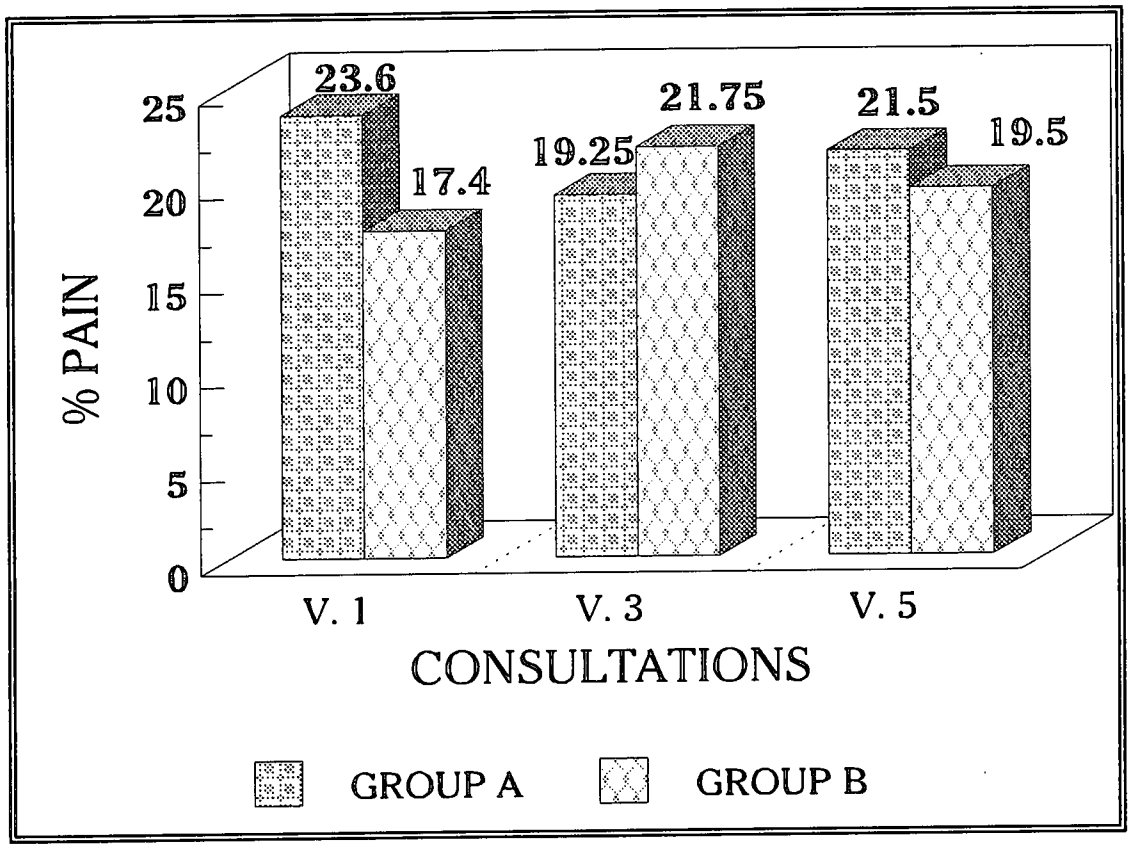

Fig 1: Changes in mean percentage of pain perception over period of evaluation.

4.5.2 MEAN CARPAL TUNNEL PAIN AND DISABILITY VALUES

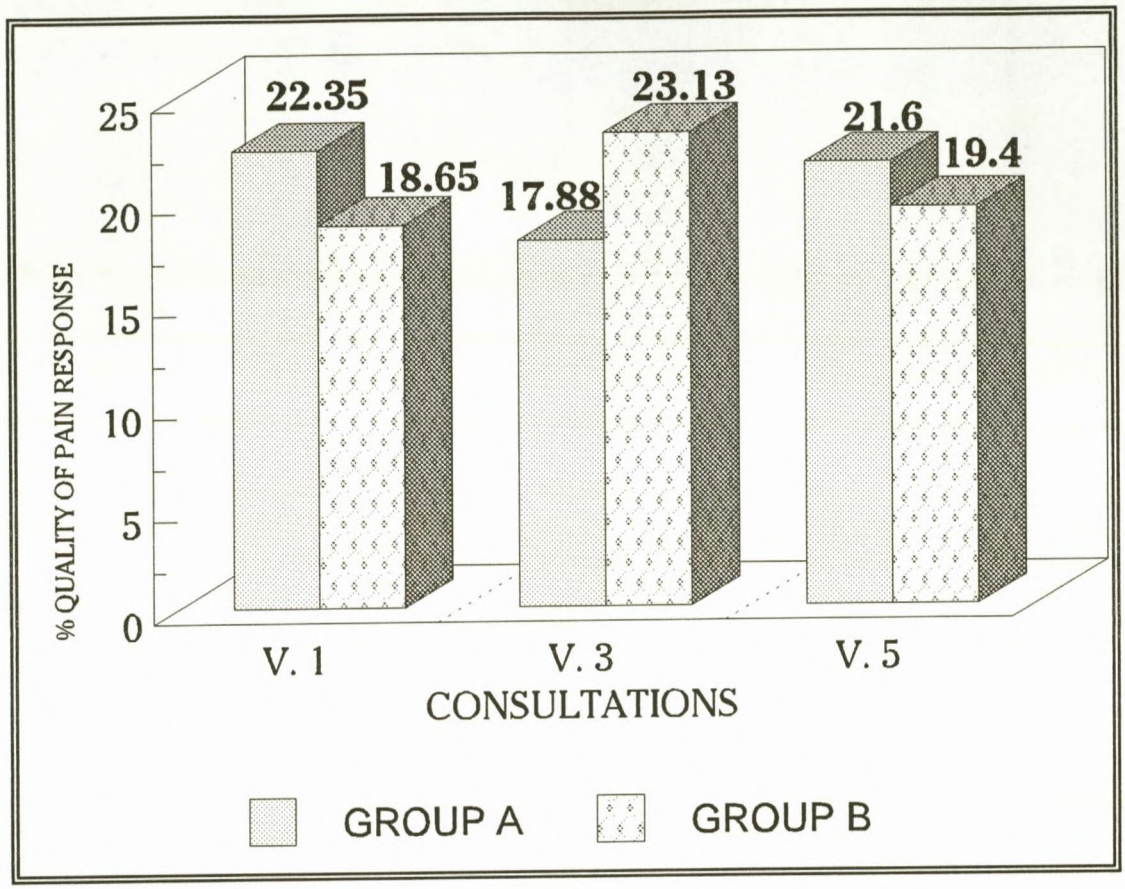

Fig 2: Changes in the mean percentage quality of pain and disability over the period of evaluation.

4.5.3 MEAN GRIP STRENGTH VALUES

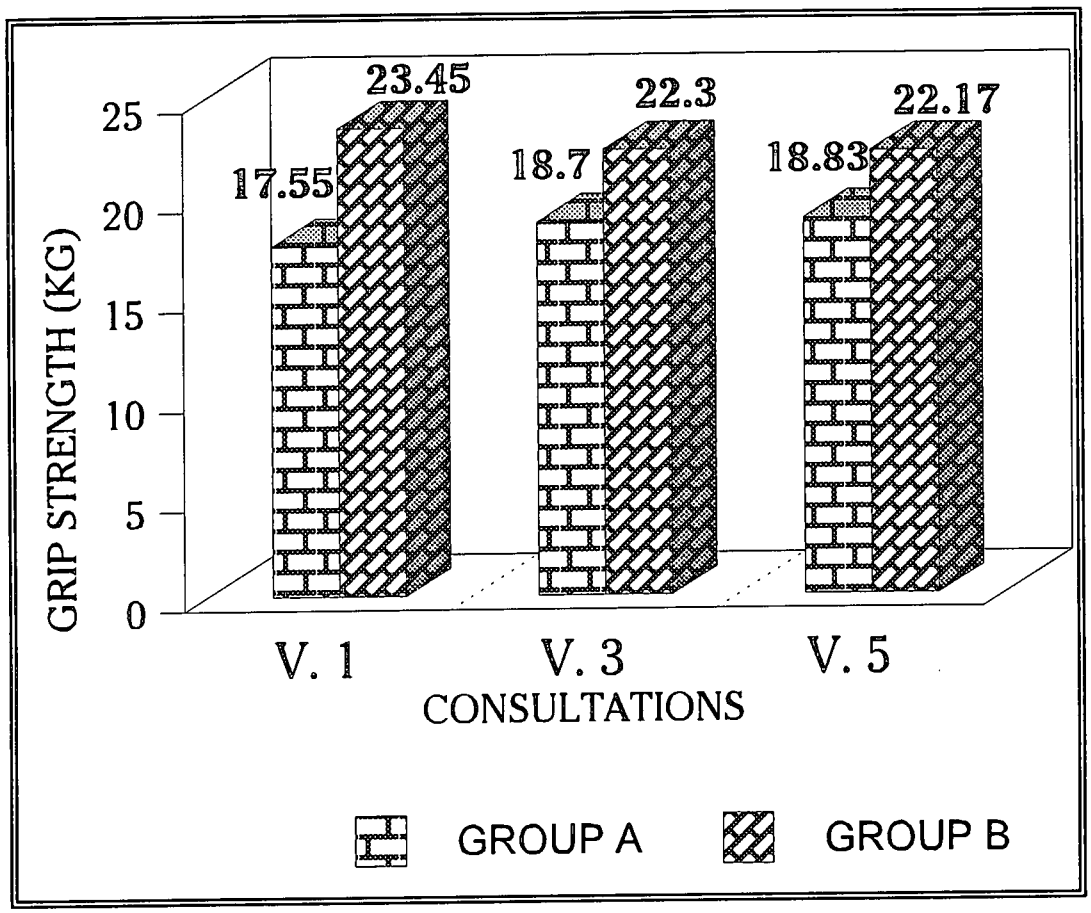

Fig 3: Changes in mean grip strength values before consultations 1, 3 and 5.

4.5.4 MEAN WRIST EXTENSION VALUES

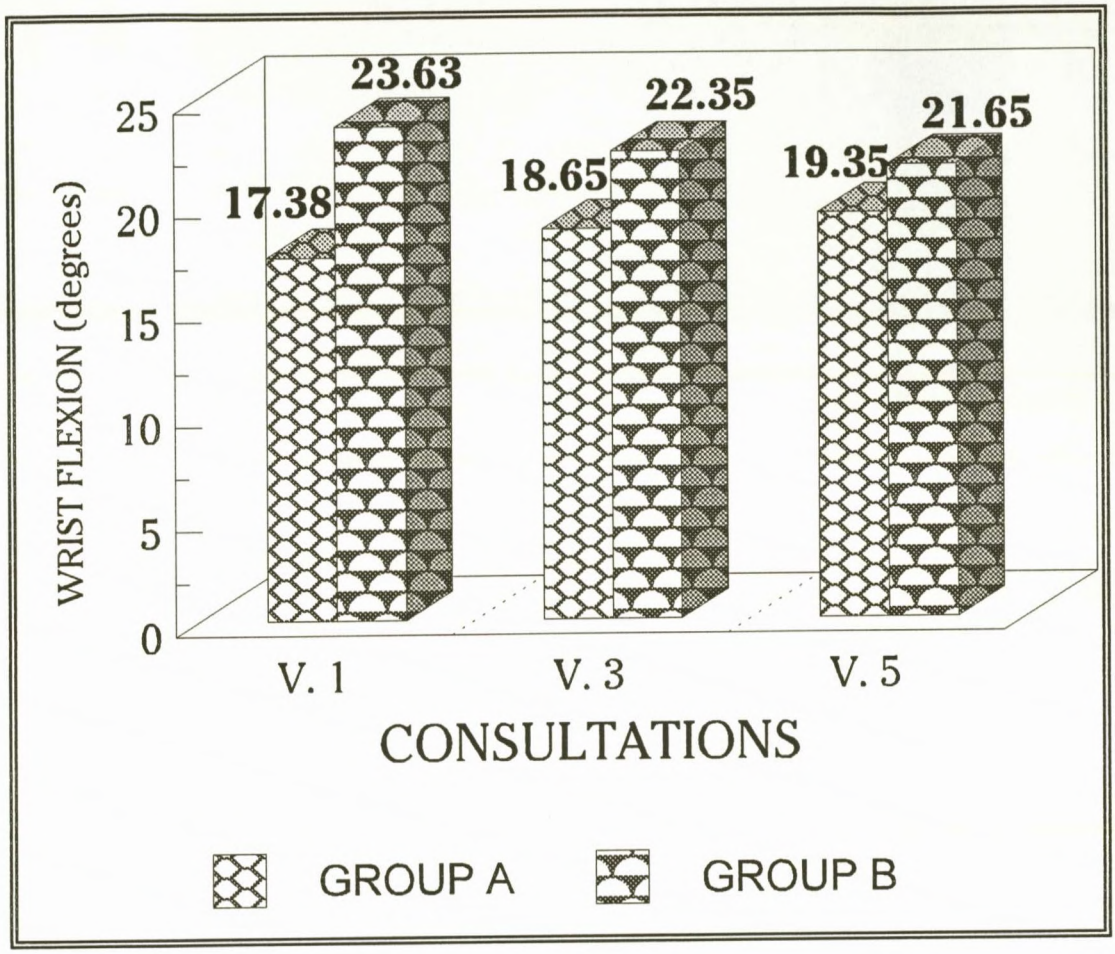

Fig 4: Changes in mean wrist flexion goniometer readings before consultations 1, 3 and 5.

4.5.5 MEAN WRIST EXTENSION VALUES

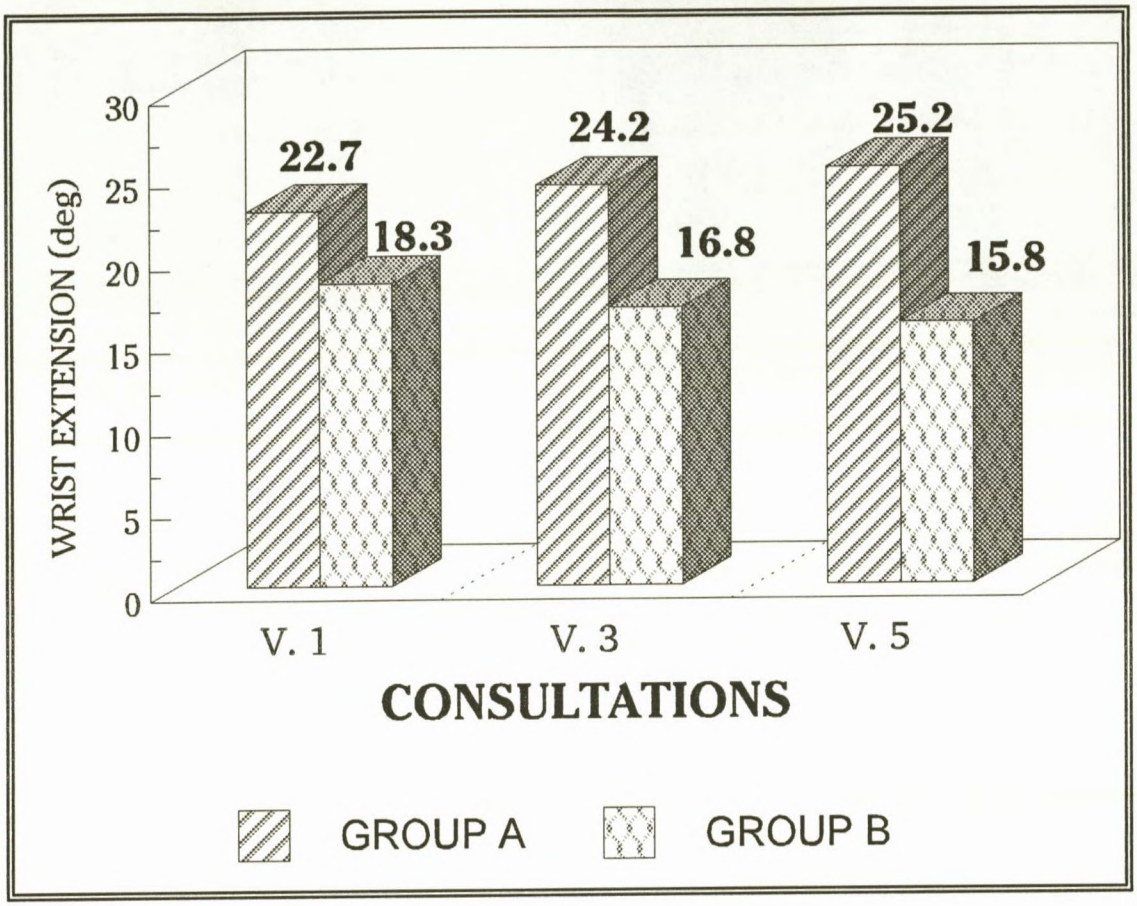

Fig.5: Changes in mean wrist extension goniometer readings before consultations 1, 3 and 5.

CHAPTER FIVE: DISCUSSION

5.1 INTRODUCTION

This chapter deals with the discussion of results after statistical analysis of the data obtained from the Numerical Rating Scale- 101, the Carpal Tunnel Pain and Disability Form, the Grip Strength reading and the Goniometer readings for wrist flexion and extension.

The results are discussed in two parts, namely: inter- group comparisons and intra- group comparisons.

5.2 INTER-GROUP COMPARISON

5.2.1 SUBJECTIVE DATA

The statistical data are located in tables 5 and 6.

Statistical analysis revealed that no statistically significant difference could be noted between group A and B at the first, third and fifth consultations with regard to the Numerical Rating Scale-101 Questionnaire and the Carpal Tunnel Pain and Disability Form.

- **The Numerical Rating Scale-101 (Table 5)**

A comparison of the first consultation of both groups revealed no significant statistical difference ($p=0.092$), which means that both groups started off at a similar point in pain/ numbness/ tingling perception. A comparison of the third and fifth consultations also revealed no statistical difference between the 2 groups ($p=0.496$ and $p=0.587$ respectively).The null

hypothesis, which states that there is no significant difference between the groups, is therefore accepted. Both treatment protocols were therefore equally effective in reducing the patients' perception of pain/ numbness/ tingling.

- **The Carpal Tunnel Pain and Disability Form (Table 6)**

A comparison of the first consultation indicated no significant statistical difference (p=0.316), which means that both groups started off similarly with regard to pain and disability perception. A comparison of the third and fifth consultations also revealed no statistically significant difference between the 2 groups (p=0.155 and p=0.551 respectively). The null hypothesis is therefore accepted. This indicates that both manipulation and ultrasound were equally effective in reducing the patient's perception of pain and disability.

5.2.2 OBJECTIVE DATA

The statistical data is located in tables7 to 9.

Statistical analysis revealed no significant difference between Group A and B with regard to grip strength and wrist flexion readings. A significant difference was noted in wrist extension readings for the third and fifth consultations.

- **Grip Strength Reading (Table 7)**

Both groups started off similarly with regard to grip strength as indicated the absence of a significant statistical difference (p=0.109). A comparison of both groups at the third and fifth consultations also revealed no significant statistical difference (p=0.329 and p=0.363

respectively). The null hypothesis is therefore accepted. This indicates that both treatment protocols were equally effective in improving the grip strength.

- **Wrist Flexion Reading (Table 8)**

No significant statistical difference (p=0.079) for wrist flexion could be noted between the both groups at the initial consultation. The third and fifth consultations also revealed no significant statistical difference (p=0.299 and p=0.517 respectively) between the groups. The null hypothesis is therefore accepted. Both treatment protocols were therefore equally effective in improving the patients' wrist flexion reading.

- **Wrist Extension Reading (Table 9)**

No significant statistical difference (p=0.230) for wrist extension could be noted between the both groups at the initial consultation. However a statistically significant difference was noted at the third and fifth consultations (p=0.043 and p=0.010 respectively). The null hypothesis is therefore rejected. The mean values for wrist extension in Group A increased in the third and fifth consultations. Wrist joint manipulation (Group A) was therefore more effective in improving wrist extension.

5.3 INTRA- GROUP COMPARISON

5.3.1 SUBJECTIVE DATA

The statistical data are located in tables 10 to 24.

It was hypothesized that there would be a difference between consultations with regards to the variable of interest in Group A, showing that wrist joint manipulation was more effective than ultrasound application in the treatment of CTS.

A significant improvement was noted in both the manipulation and ultrasound groups for the Numerical Rating Scale- 101 and the Carpal Tunnel Pain and Disability Form.

◎ The Numerical Rating Scale-101 (Table 10, 15 and 16)

An analysis of visits one, three and five revealed a statistically significant difference in Group A and B ($p=0.000$ and $p=0.0005$ respectively) indicating a decrease in the level of pain perception (table 10). A multiple comparison procedure (Dunn's procedure) was therefore used to determine at which point the treatment made a significant difference.

In Group A, a significant improvement was noted between visits 1 and 3, and 1 and 5 but no significant improvement was demonstrated between visits 3 and 5 with regard to the subjective data on pain perception (table 15).

In Group B, a significant improvement was seen between visits 1 and 5, and 3 and 5 but no significant improvement was demonstrated between visits 1 and 3 with regard to the subjective data on pain perception (table 16). This indicates that therapists should not dismiss the treatment protocols after the first two treatments if no improvement occurs, as it is likely that improvement will occur within the next few treatments.

◎ The Carpal Tunnel Pain and Disability Form (Table 11, 17 and 18)

An analysis of visits one, three and five revealed a statistically significant difference in Group

A and B (p=0.000 and p=0.0005 respectively) indicating a decrease in the level of pain and disability perception (table 11). The multiple comparison procedure (Dunn's procedure) was then used to determine at which point the treatment made a significant difference.

In Group A, a significant improvement between visits 1 and 3, and 1 and 5 was noted but no significant improvement was demonstrated between visits 3 and 5 with regard to the subjective data on pain and disability perception (table 17).

A significant improvement was demonstrated between visits 1 and 5, and 3 and 5 but no significant improvement was seen between visits 1 and 3 with regard to the subjective data on pain and disability perception for Group B (table 18).

5.3.2 OBJECTIVE DATA

The statistical data are located in tables 12 to 24.

A significant improvement was noted in both the manipulation and ultrasound groups with regard to grip strength, wrist flexion and wrist extension readings.

○ Grip Strength Reading (Tables 12, 19 and 20)

Analysis of the results between visits one, three and five revealed a statistically significant difference in Groups A and B (p=0.005 and p=0.0025 respectively) indicating an increase in the grip strength (table 12). The multiple comparison procedure (Dunn's procedure) was then used to determine at which point the treatment made a significant difference.

A significant improvement was revealed between visits 1 and 5, but no significant improvement was demonstrated between visits 1 and 3 and visits 3 and 5 with regard to the grip strength reading for Group A (table 19).

In Group B, a significant improvement was demonstrated between visits 1 and 5, but no significant improvement was demonstrated between visits 1 and 3 and visits 3 and 5 with regard to the grip strength reading (table 20).

◉ Wrist Flexion Reading (Tables 13, 21 and 22)

Analysis of the results between visits one, three and five revealed a statistically significant difference in Groups A and B ($p=0.000$ and $p=0.0005$ respectively) indicating an increase in the wrist flexion reading (table 13). The multiple comparison procedure (Dunn's procedure) was then used to determine at which point the treatment made a significant difference.

In Group A, a significant improvement existed between visits 1 and 3, and 1 and 5 but no significant improvement was demonstrated between visits 3 and 5 with regard to the wrist flexion goniometer reading (table 21).

A significant improvement was revealed between visits 1 and 3, and 1 and 5 but no significant improvement was noted between visits 3 and 5 with regard to the wrist flexion goniometer reading for Group B (table 22).

◉ Wrist Extension Reading (Tables 14, 23 and 24)

An analysis of visits one, three and five revealed a statistically significant difference in Group A and B ($p=0.000$ and $p=0.0205$ respectively) indicating a decrease in the level of pain perception (table 14). This warranted the use of the multiple comparison procedure (Dunn's procedure) to determine at which point the treatment made a significant difference.

A significant improvement between visits 1 and 3, and 1 and 5 was revealed but no significant improvement was demonstrated between visits 3 and 5 with regard to the wrist extension goniometer reading for Group A (table 23).

In Group B, no significant improvement was revealed between visits 1 and 3, 1 and 5 and visits 3 and 5 with regard to the wrist extension goniometer reading for Group B (table 24).

5.4 CONCLUSIONS

From the above data it can be concluded that both manipulation and ultrasound are equally effective in treating CTS. Inter-group comparisons revealed that both treatments improved the subjects' pain perception, disability perception, grip strength and wrist flexion. Wrist joint manipulation, however was more effective than ultrasound in improving the subjects' wrist extension readings. Intra-group analysis revealed that both treatment protocols showed significant improvements between the consultations.

5.5 COMPARISON OF THE RESULTS WITH OTHER STUDIES

This is the first study to compare the effectiveness of wrist joint manipulation and ultrasound in the management of Carpal Tunnel Syndrome.

Many studies have investigated the effectiveness of conservative care in the management of CTS (Bonebrake et al. 1990 and 1993, Valente 1990, Valente and Gibson 1994, and Ebenbichler et al. 1998).

Bonebrake et al. (1990) in a study (N=51) on the effectiveness of soft tissue therapy, ultrasound, dietary advice and hard tissue manipulation of the spine and upper extremity joints on CTS, similarly found that there was an improvement in patient's pain and distress values, joint range of motion and grip strength readings. Although this study suggests that wrist manipulation is beneficial in the treatment of CTS, no strong conclusions can be drawn as the treatment protocol consisted of several different therapies, was not placebo-controlled, and therefore does not distinguish which modalities are beneficial and necessary, and which are

not.

Valente (1991) performed a case study on a 44 year old male with CTS. It revealed that, chiropractic adjustments of the wrist, elbow and cervical spine, as well as splinting and ice, ultrasound and vitamin B6 seemed to benefit the patient more than medical treatment of Motrin and cortisone injections into the wrist. This study supports the results of the current study in that manipulation and ultrasound were beneficial in the management of CTS. However it does not provide any conclusive evidence that the treatment is effective as the sample size was one, there was no control group and a combination of therapies was used.

Valente and Gibson (1994) performed a case study on a 42 year old female with CTS. They also demonstrated that chiropractic manipulations three times a week for four weeks to the subject's cervical spine, elbow and wrist produced a significant improvement in subjective and objective measures. This study although only investigating one therapy i.e. manipulation, does not provide sufficient evidence of the benefits of manipulation as only one patient was used and a control was not included, thus ignoring the placebo effect.

A placebo-controlled study performed by Ebenbichler et al. (1998) on forty-five patients similarly demonstrated the benefit of ultrasound in the treatment of CTS. They showed an improvement in subjective and objective symptoms, in the active treatment group. These results were maintained at a six month follow-up examination. One problem with this study was that the subjective findings in each wrist could have been influenced by the effect of the treatment applied to the opposite wrist.

The current study on CTS has shown that wrist joint manipulation and ultrasound are both effective treatments for CTS. Furthermore it has revealed that both treatment protocols are equally effective in treating CTS. This study is however unable to clarify which treatment protocol is more effective in the management of CTS. The above studies are supported by the results of this study.

CHAPTER SIX

6.1 RECOMMENDATIONS

Should this study be repeated, the following improvements are recommended by the author.

- **Follow-up study**

A follow- up reassessment of patients after six months is recommended to establish the long-term benefits of both treatment protocols.

- **Further research**

Another study investigating the effectiveness of wrist joint manipulation, ultrasound and a combination of both therapies should be performed to determine if a combination of both treatments proves to be more effective than any of the treatments alone.

- **Sample size**

A larger sample size should be selected, where the randomization procedure takes into account age, gender, racial distribution and occupation. This would be a more accurate representation of the population. The accuracy of statistical analysis would be enhanced. A larger sample size may also allow the research to detect any difference in the efficacy of wrist joint manipulation and ultrasound in the management of CTS.

- **Placebo group**

A placebo group should be utilized in the study. This will also allow more conclusive evidence to be drawn.

- **Accuracy of measurements**

The instrumentation used, particularly the goniometer, should be more sensitive to detect

small but significant changes between treatments. In particular, it should ensure that the neutral position of the wrist before taking readings is kept constant. This will help decrease Type 1 errors from occurring.

- **Cross- over design**

A cross-over design should be considered with the 2 groups. Those patients not showing adequate improvement in their signs and symptoms can be changed over to the opposite treatment group to determine if any improvement occurs.

6.2 CONCLUSION

This was a prospective, randomised controlled clinical trial. All subjects had to be diagnosed with Carpal Tunnel Syndrome according to certain criteria. The study population consisted of 40 patients, who were randomly allocated to 2 groups of 20 each.

Group A received wrist joint manipulation and Group B received ultrasound application to the radio-palmar aspect of the wrist. Both groups received four treatments over a two week period followed by a fifth follow-up visit for recording of readings.

Intra-group analysis has revealed that in each treatment protocol, subjects showed significant improvement in both the subjective (NRS-101 and Carpal Tunnel Pain and Disability Form) and objective measures (Grip Strength and Goniometer readings for wrist flexion and extension). It also revealed that significant improvement did not occur within the first two treatments for most of the measures, but most improvement occurred in the subsequent treatments. This is why therapists should not dismiss a treatment protocol if no improvement occurs within two treatments.

Inter-group analysis revealed that both treatments were equally effective in the management

of CTS.

This study indicates that both ultrasound and wrist joint manipulation are effective in the treatment of CTS and strongly recommends further research. Patients should be made more aware of conservative treatment as an alternative to surgery. Conservative care, as this study and many others have shown, is cost-effective, decreases the need for medication, and involves less time away from work as compared to surgery, which until recently was a very popular method of managing CTS.

The results of this study suggest that both conservative treatment protocols, wrist joint manipulation and ultrasound, are effective in the management of CTS and should thus be included as an integral part in the management of CTS. This study however has not been able to determine which treatment protocol was more effective in managing CTS.

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APPENDIX A

RESEARCH INFORMATION SHEET

Dear Patient,

TITLE OF STUDY: **The relative effectiveness of wrist joint manipulation and ultrasound in the treatment of carpal tunnel syndrome.**

This research project forms part of the requirement for the completion of my Master's Degree in Technology: Chiropractic.

I, Karuna Maharajh, will be conducting the study and will be supervised by Dr A van der Meulen.

The purpose of this study is to determine a more effective treatment for carpal tunnel syndrome. You will be randomly allocated to one of two groups of thirty patients each. One group will receive wrist joint manipulation and the other will receive ultrasound.

You will be questioned extensively on your wrist condition and your health in general. A physical examination and wrist examination will be conducted and you will be required to complete questionnaires. Management will involve four treatments over a two week period and a fifth follow-up visit for the recording of readings. The duration of the first consultation is approximately one hour, while the follow-up visits will take about thirty minutes each. Measurements will be taken intermittently over the treatment period. Should you decide to participate in the study, it is important that you do not take any form of medication or other treatment for your condition during the period of the study. There is a minimal risk of the condition being exacerbated by either treatment. Please try to be as accurate as possible when completing the questionnaires and rating scales. Treatment is free of charge.

All information disclosed will be kept strictly confidential although authorities may inspect the records. Should you require any further information pertaining to this study, please do not hesitate to ask. Your questions can also be answered by the supervisor of this research study, Dr. A. van der Meulen who is at the clinic on Monday mornings till noon. Should you have any problems with the conduction of the study, complaints can be forwarded to the Technikon Research Ethics Committee.

I thank you in anticipation of your co-operation.

_____

Miss. K. Maharajh

DATE: _____

APPENDIX B

INFORMED CONSENT FORM (To be completed by patient/subject)

TITLE OF RESEARCH PROJECT: **The relative effectiveness of wrist joint manipulation versus ultrasound in the management of Carpal Tunnel Syndrome.**

DATE : _____
NAME OF SUPERVISOR : Dr. A. van der Meulen
NAME OF RESEARCH STUDENT : Karuna Maharajh
INSTITUTION : Technikon Natal

PLEASE CIRCLE THE APPROPRIATE ANSWER	**YES NO**
1. Have you read the research information sheet?	Yes No
2. Have you had an opportunity to ask questions regarding this study?	Yes No
3. Have you received satisfactory answers to your questions?	Yes No
4. Have you had an opportunity to discuss this study?	Yes No
5. Have you received enough information about this study?	Yes No
6. Who have you spoken to? _____	
7. Do you understand the implications of your involvement in this study?	Yes No
8. Do you understand that you are free to withdraw from this study? a. at any time b. without having to give any reason for withdrawing, and c. without affecting your future health care.	Yes No
9. Do you understand that the researcher may terminate your participation, if necessary?	Yes No
10. Do you understand that you have a right to be informed of any new findings?	Yes No
11. Do you agree to voluntarily participate in this study?	Yes No
12. Do you understand that you may receive either wrist adjustments or ultrasound of the wrist?	Yes No

If you have answered no to any of the above, then please obtain the necessary **information before signing.**

PLEASE PRINT IN BLOCK LETTERS:

Patient/Subjectname:_____Signature:_____

Parent/Guardian:_____ Signature:_____

Witness Name: _____ Signature:_____

APPENDIX C

CARPAL TUNNEL (MEDIAN NERVE) PAIN AND DISABILITY FORM

Symptom severity scale

The following questions refer to your symptoms for a typical twenty-four-hour period during the past two weeks (circle one answer to each question).

How severe is the hand or wrist pain that you have at night? 1. I do not have hand or wrist pain at night 2. Mild pain 3. Moderate pain 4. Severe pain 5. Very severe pain	**How long, on average, does an episode of pain last during the daytime?** 1. I never get pain during the day 2. Less than 10 minutes 3. 10 to 60 minutes 4. Greater than 60 minutes 5. The pain is constant throughout the day
How often did hand or wrist pain wake you up during a typical night in the past two weeks? 1. Never 2. Once 3. Two or three times 4. Four or five times 5. More than five times	**Do you have numbness (loss of sensation) in your hand?** 1. No 2. I have mild numbness 3. I have moderate numbness 4. I have severe numbness 5. I have very severe numbness
Do you typically have pain in you hand or wrist during the daytime? 1. I never have pain during the day 2. I have mild pain during the day 3. I have moderate pain during the day 4. I have severe pain during the day 5. I have very severe pain during the day	**Do you have weakness in your hand or wrist?** 1. No weakness 2. Mild weakness 3. Moderate weakness 4. Severe weakness 5. Very severe weakness
How often do you have hand or wrist pain during the daytime? 1. Never 2. Once or twice a day 3. Three to five times a day 4. More than five times a day 5. The pain is constant	**Do you have tingling sensations in your hand?** 1. No tingling 2. Mild tingling 3. Moderate tingling 4. Severe tingling 5. Very severe tingling
How severe is numbness (loss of sensation) or tingling at night? 1. I have no numbness or tingling at night 2. Mild 3. Moderate 4. Severe 5. Very severe	**Do you have difficulty with the grasping and use of small objects such as keys or pens?** 1. No difficulty 2. Mild difficulty 3. Moderate difficulty 4. Severe difficulty 5. Very severe difficulty
How often did hand numbness or tingling wake you during a typical night during the past two weeks? 1. Never 2. Once 3. Two or three times 4. Four or five times 5. More than five times	

APPENDIX D

NUMERICAL RATING SCALE- 101 QUESTIONNAIRE

DATE: _____ FILE NO.:_____ VISIT NO.:_____

PATIENT NAME: _____

Please indicate on the line below, the number between 0 and 100 that best describes the pain/numbness/tingling you experience **when it is at its worst**. A zero (0) would mean "no pain at all", and one hundred (100) would mean "pain as bad as it could be".

Please write only **one** number.

_____

Please indicate on the line below, the number between 0 and 100 that best describes the pain/numbness/tingling you experience **when it is at its least.** A zero (0) would mean "no pain at all", and one hundred (100) would mean "pain as bad as it could be".

Please write only **one** number.

_____

APPENDIX E

GONIOMETER READINGS

PATIENT NAME: _____

FILE NO: _____

TREATMENT NUMBER	DATE	GONIOMETER L E F T		READINGS R I G H T	
		Flexion	Extension	Flexion	Extension
PRE- 1					
PRE- 3					
FOLLOW-UP 5					

APPENDIX F

GRIP STRENGTH READINGS

PATIENT NAME: _____

FILE NUMBER: _____

TREATMENT NUMBER	DATE	GRIP STRENGTH READINGS Left	Right
PRE- 1			
PRE- 3			
FOLLOW-UP 5			

APPENDIX G

TECHNIKON NATAL CHIROPRACTIC DAY CLINIC
CASE HISTORY

Patient:_____ Date: _____
file #:_____ X-Ray#:_____
Age:_____ Sex:_____ Occupation:_____
Intern:_____ Signature:_____

FOR CLINICIAN'S USE ONLY
Initial visit clinician:_____Signature:_____

Case History:

Examination:
Previous: Current:

X-Ray Studies:
Previous: Current:

Clinical Path. lab:
Previous: Current:

Case Status:

PTT: Conditional: Signed Off: Final Sign out:

Recommendations:

Intern's Case History

1. Source of History:

2. Chief Complaint: (patient's own words)

3. Present Illness:

- Location
- Onset
- Duration
- Frequency
- Pain (Character)
- Progression
- Aggravating Factors
- Relieving Factors
- Associated S & S
- Previous Occurrences
- Past Treatment and Outcome

4. Other Complaints:

5. Past Medical History:

- General Health Status
- Childhood Illnesses
- Adult Illnesses
- Psychiatric Illnesses
- Accidents/Injuries
- Surgery
- Hospitalizations

6. Current health status and life-style:

- Allergies
- Immunizations
- Screening Tests
- Environmental Hazards (Home, School, Work)
- Safety Measures (seat belts, condoms)
- Exercise and Leisure
- Sleep Patterns
- Diet
- Current Medication
- Tobacco
- Alcohol
- Social Drugs

7. Immediate Family Medical History:

- Age
- Health
- Cause of Death
- DM
- Heart Disease
- TB
- Stroke
- Kidney Disease
- CA
- Arthritis
- Anaemia
- Headaches
- Thyroid Disease
- Epilepsy
- Mental Illness
- Alcoholism
- Drug Addiction
- Other

8. Psychosocial history:

- Home Situation and daily life
- Important experiences
- Religious Beliefs

9. Review of Systems:

- General
- Skin
- Head
- Eyes
- Ears
- Nose/Sinuses
- Mouth/Throat
- Neck
- Breasts
- Respiratory
- Cardiac
- Gastro-intestinal
- Urinary
- Genital
- Vascular
- Musculoskeletal
- Neurologic
- Haematologic
- Endocrine
- Psychiatric

APPENDIX H

TECHNIKON NATAL

TECHNIKON NATAL CHIROPRACTIC DAY CLINIC

PHYSICAL EXAMINATION

Patient:_____ File#: _____ Date:_____
Clinician:_____ Signature:_____
Intern:_____ Signature:_____

1. VITALS

Pulse rate:
Respiratory rate:
Blood pressure: R L
Temperature:
Height:
Weight:

2. GENERAL EXAMINATION

General Impression:
Skin:
Jaundice:
Pallor:
Clubbing:
Cyanosis (Central/Peripheral):
Oedema:
Lymph nodes - Head and neck:
- Axillary:
- Epitrochlear:
- Inguinal:

Urinalysis:

3. CARDIOVASCULAR EXAMINATION

1) Is this patient in **Cardiac Failure** ?
2) Does this patient have signs of **Infective Endocarditis** ?
3) Does this patient have **Rheumatic Heart Disease ?**

Inspection - Scars
- Chest deformity:
- Precordial bulge:
- Neck -JVP:

Palpation: - Apex Beat (character + location):
- Right or left ventricular heave:
- Epigastric Pulsations:
- Palpable P2:
- Palpable A2:

Pulses:
- General Impression:
- Radio-femoral delay:
- Carotid:
- Radial:
- Dorsalis pedis:
- Posterior tibial:
- Popliteal:
- Femoral:

Percussion: - borders of heart

Auscultation:
- heart valves (mitral, aortic, tricuspid, pulmonary)
- Murmurs (timing.systolic/diastolic, site, radiation, grade).

4. RESPIRATORY EXAMINATION

1) Is this patient in **Respiratory Distress** ?

Inspection
- Barrel chest:
- Pectus carinatum/cavinatum:
- Left precordial bulge:
- Symmetry of movement:
- Scars:

Palpation
- Tracheal symmetry:
- Tracheal tug:
- Thyroid Gland:
- Symmetry of movement (ant + post)
- Tactile fremitus:

Percussion
- Percussion note:
- Cardiac dullness:
- Liver dullness:

Auscultation
- Normal breath sounds bilat.:
- Adventitious sounds (crackles, wheezes, crepitations)
- Pleural frictional rub:
- Vocal resonance
  - Whispering pectoriloquy:
  - Bronchophony:
  - Egophony:

5. ABDOMINAL EXAMINATION

1) Is this patient in **Liver Failure** ?

Inspection
- Shape:
- Scars:
- Hernias:

Palpation
- Superficial:
- Deep = Organomegally:

- Masses (intra- or extramural)
- Aorta:

Percussion - Rebound tenderness:
- Ascites:
- Masses:

Auscultation - Bowel sounds:
- Arteries (aortic, renal, iliac, femoral, hepatic)

Rectal Examination
- Perianal skin:
- Sphincter tone & S4 Dermatome:
- Obvious masses:
- Prostate:
- Appendix:

6. G.U.T EXAMINATION

External genitalia:
Hernias:
Masses:
Discharges:

7. NEUROLOGICAL EXAMINATION

Gait and Posture
- Abnormalities in gait:
- Walking on heels (L4-L5):
- Walking on toes (S1-S2):
- Rombergs test (Pronator Drift):

Higher Mental Function
- Information and Vocabulary:
- Calculating ability:
- Abstract Thinking:

G.C.S.:
- Eyes:
- Motor:
- Verbal:

Evidence of head trauma:

Evidence of Meningism:
- Neck mobility and Brudzinski's sign:
- Kernigs sign:

Cranial Nerves:

I Any loss of smell/taste:
Nose examination:

II External examination of eye:
- Visual Acuity:
- Visual fields by confrontation:

- Pupillary light reflexes = Direct:
  = Consensual:
- Fundoscopy findings:

III Ocular Muscles:
Eye opening strength:

IV Inferior and Medial movement of eye:

V a. Sensory - Ophthalmic:
- Maxillary:
- Mandibular:

b. Motor - Masseter:
- Jaw lateral movement:

c. Reflexes - Corneal reflex
- Jaw jerk

VI Lateral movement of eyes

VII a. Motor - Raise eyebrows:
- Frown:
- Close eyes against resistance:
- Show teeth:
- Blow out cheeks:

b. Taste - Anterior two-thirds of tongue:

VIII General Hearing:
Rinnes = L: R:
Webers lateralisation:
Vestibular function - Nystagmus:
- Rombergs:
- Wallenbergs:
Otoscope examination:

IX & X Gag reflex:
Uvula deviation:
Speech quality:

XI Shoulder lift:
S.C.M. strength:

XII Inspection of tongue (deviation):

Motor System:

a. Power
- Shoulder = Abduction & Adduction:
  = Flexion & Extension:
- Elbow = Flexion & Extension:
- Wrist = Flexion & Extension:

- Forearm = Supination & Pronation:
- Fingers = Extension (Interphalangeals & M.C.P's):
- Thumb = Opposition:
- Hip = Flexion & Extension:
  = Adduction & Abduction:
- Knee = Flexion & Extension:
- Foot = Dorsiflexion & Plantar flexion:
  = Inversion & Eversion:
  = Toe (Plantarflexion & Dorsiflexion):

b. Tone
- Shoulder:
- Elbow:
- Wrist:
- Lower limb - Int. & Ext. rotation:
- Knee clonus:
- ankle clonus:

c. Reflexes
- Biceps:
- Triceps:
- Supinator:
- Knee:
- Ankle:
- Abdominal:
- Plantar:

Sensory System:

a. Dermatomes
- Light touch:
- Crude touch:
- Pain:
- Temperature:
- Two point discrimination:

b. Joint position sense
- Finger:
- Toe:

c. Vibration:
- Big toe:
- Tibial tuberosity:
- ASIS:
- Interphalangeal Joint:
- Sternum:

Cerebellar function:

Obvious signs of cerebellar dysfunction:
= Intention Tremor:
= Nystagmus:
= Truncal Ataxia:

Finger-nose test (Dysmetria):
Rapid alternating movements (Dysdiadochokinesia):
Heel-shin test:
Heel-toe gait:
Reflexes:
Signs of Parkinsons:

8. **SPINAL EXAMINATION:**(See Regional examination)

Obvious Abnormalities:
Spinous Percussion:
R.O.M:
Other:

9. **BREAST EXAMINATION:**

Summon female chaperon.

Inspection
- Hands rested in lap:
- Hands pressed on hips:
- Arms above head:
- Leaning forward:

Palpation
- masses:
- tenderness:
- axillary tail:
- nipple:
- regional lymph nodes:

APPENDIX I

TECHNIKON NATAL

Hand and wrist regional examination

Patient:_____ File no:_____ Date:_____
Intern:_____ Signature:_____
Clinician:_____ Signature:_____

Observation:

- bony and soft tissue contours_____
- hand posture_____
- vasomotor changes_____
- scars, skin creases, and muscle wasting_____
- fingernails_____
- dominant hand right_____ left_____

Palpation:

Posterior surface

1. Anatomical snuff box_____
2. Carpal bones_____
3. Metacarpal bones_____
4. Phalanges_____
5. Pulses and capillary refill_____
6. Radial styloid_____
7. Radial (lister's) tubercle_____
8. Ulnar styloid_____
9. 6 extensor tendon tunnels
   - i. Abd poll long _____
     Ext poll brev _____
   - ii. ECRB_____
     ECRL_____
   - iii. Ext poll long_____
   - iv. Ext digit_____
     Ext index_____
   - v. Ext digiti mini_____
   - vi. ECU_____

Anterior surface

1. Tendons (Lat to med)
   a. Flexor carpi radialis_____
   b. Flexor poll longus_____
   c. Flexor digit super_____
   d. Flexor digit profund_____
   e. Palmaris long_____
   f. Flexor carpi ulnaris_____
2. Palmar fascia and intrinsic muscles_____

Active movements: **Passive movements:**

Pronation (85-90°)_____ Tissue stretch_____
Supination (85-90°)_____ Tissue stretch_____
Ulnar deviation (15°)_____ Bone-bone_____
Radial deviation (30-45°)_____ Bone-bone_____
Wrist flexion (80-90°)_____ Tissue stretch_____
Wrist extension (70-90°)_____ Tissue stretch_____
Finger movements_____
Thumb movements_____

Resisted isometric movements:_____

_____

_____

Functional movements:

GROSS GRIP STRENGTH:

fist grip:_____

cylinder grip:_____

hook grip:_____

sphere grip:_____

PRECISION GRIP STRENGTH:

pinch:_____

chuck:_____

key:_____

Special tests:

1. Finkelstein's test:_____
2. Tinel's:_____
3. Phalan's test:_____
4. Reverse phalan's test:_____
5. Allen's test:_____
6. Froment's sign:_____
7. Watson's test:_____
8. Scaphoid compression test:_____
9. Lunatotriquetral ballottment test:_____
10. Bunnel littler test:_____
11. Tight retinacular test:_____
12. Ligament stability:_____

Joint play movements:

I. Hand and fingers

A. MCP and PIP + DIP
   1. Long axis extension_____
   2. AP, PA glide_____
   3. Rotation_____
   4. Side glide_____

B. Distal inter-metacarpals
   1. AP, PA glide_____
   2. Rotation_____

II. Wrist

A. Long axis extension_____
B. AP glide_____
C. Carpal extension_____
D. Carpal flexion_____
E. Ulnar deviation_____
F. Radial deviation_____
G. Ul-men-triq AP+ PA glide_____
H. Inf rad-ulnar rotation
   1. AP, PA glide_____
   2. Rotation_____

Radiographic examination:_____

_____

_____

_____

Diagnosis:_____

_____

Treatment:_____

_____

_____

APPENDIX J

EXAMPLE OF ADVERTISEMENT

ARE YOU BETWEEN THE AGES OF **16** AND **60**?

DO YOU HAVE **WRIST/ HAND PAIN**?

IS YOUR PAIN WORSE AT **NIGHT?**

DO YOU HAVE **TINGLING/ NUMBNESS/ BURNING** IN YOUR **THUMB AND FIRST 3 FINGERS**?

YOU MAY HAVE **CARPAL TUNNEL SYNDROME** !

RESEARCH IS CURRENTLY BEING CONDUCTED INTO THIS CONDITION AT THE TECHNIKON NATAL CHIROPRACTIC CLINIC.

FREE TREATMENT IS AVAILABLE TO PERSONS MEETING THE RESEARCH CRITERIA.

SHOULD YOU BE INTERESTED IN PARTICIPATING IN THIS PROGRAM, YOU MAY KINDLY CONTACT:
KARUNA

☎ **2042205/2042512**